PROJECTS ■ THEORY ■ APPLICATIONS ■ CIRCUITS ■ TECHNOLOGY

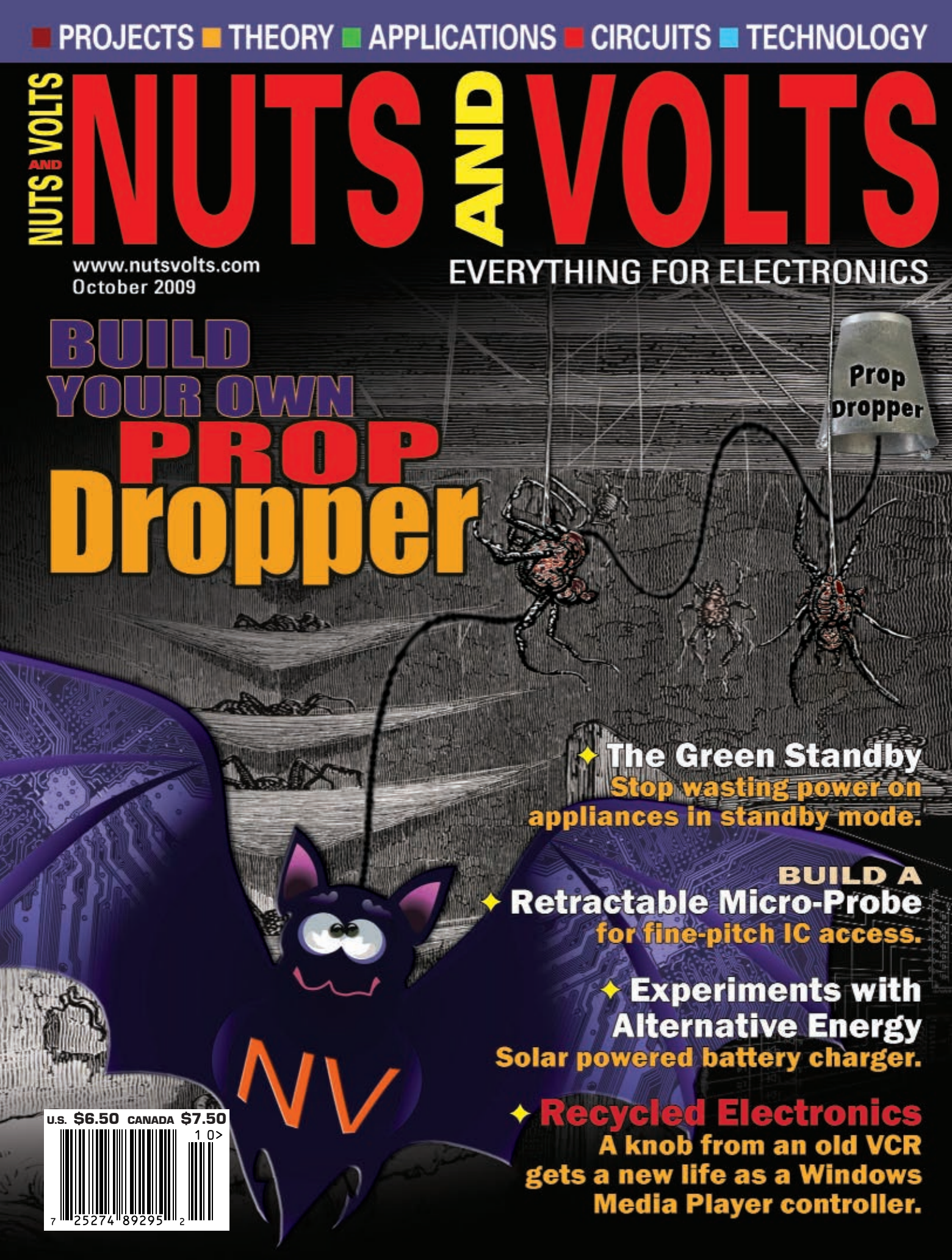
NUTS AND VOLTS

NUTS AND VOLTS

www.nutsvolts.com
October 2009

EVERYTHING FOR ELECTRONICS

BUILD YOUR OWN PROP Dropper



✦ The Green Standby
Stop wasting power on appliances in standby mode.

BUILD A ✦ Retractable Micro-Probe
for fine-pitch IC access.

✦ Experiments with Alternative Energy
Solar powered battery charger.

✦ Recycled Electronics
A knob from an old VCR gets a new life as a Windows Media Player controller.

U.S. $6.50 CANADA $7.50
10>
7 25274 89295 2

All displays shown are actual size

SerialLCD™

BasicX.com

RoHS 2002/95/EC COMPLIANT

NetMedia Inc., 10940 N Stallard Pl, Tucson Arizona 85737 tel.520.544.4567 fax.520.544.0800 www.netmedia.com

Let your geek shine.

Meet Vanessa Carpenter and Dzl Møbius, SparkFun customers and developers of the Critical Corset. Using a heart rate monitor, an Arduino, and a cleverly hidden air pump system, Vanessa and Dzl designed a corset that explores the rules of attraction. As the user's heart rate increases, the corset gently tightens, creating a more confident posture.

Whether you need a heart rate monitor or just a handful of LEDs, the tools are out there. Create a project you'll love, and let your geek shine too.

sparkfun™ ELECTRONICS

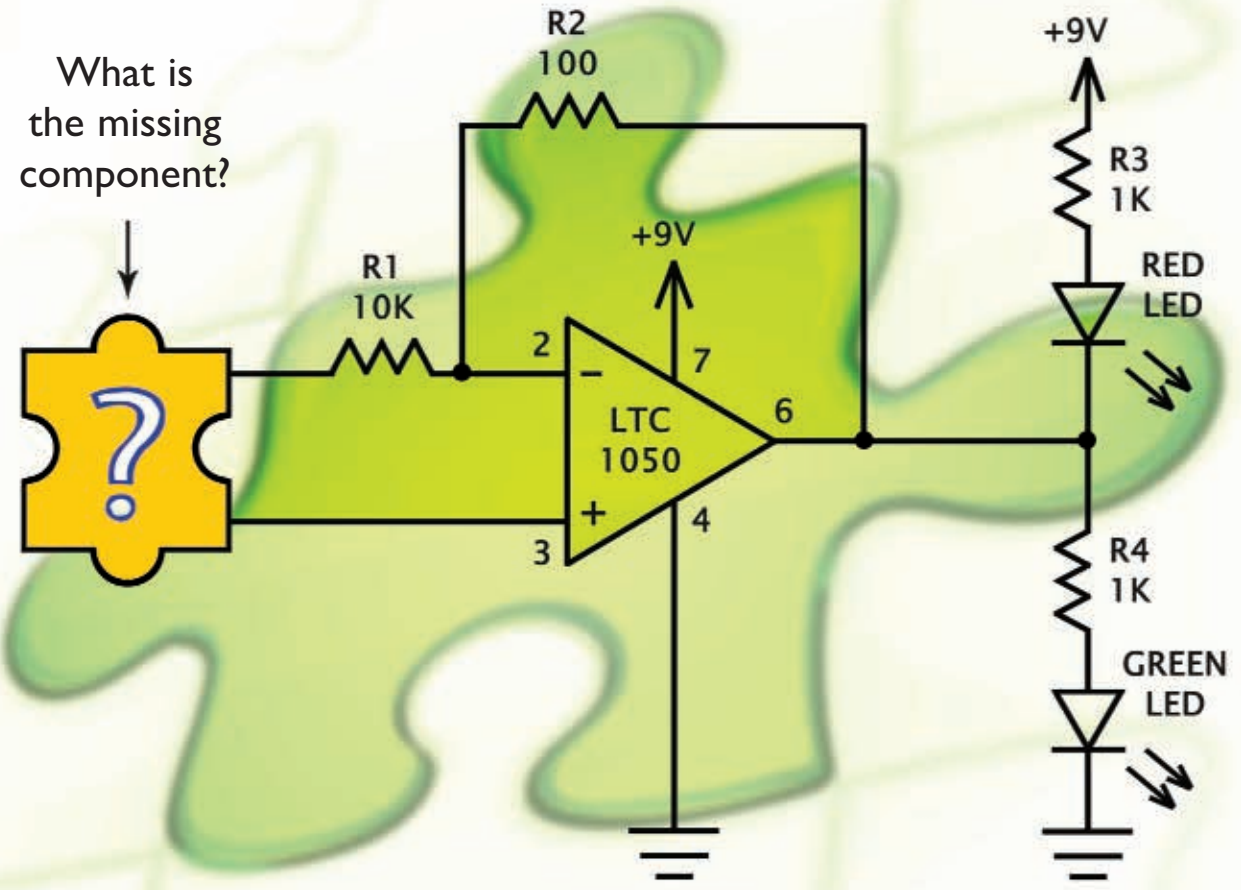
Sharing Ingenuity

WWW.SPARKFUN.COM

©2009 SparkFun Electronics, Inc. All rights reserved. All other trademarks contained herein are the property of their respective owners. Arduino is released under the Creative Commons Attribution Share-Alike 3.0 License.

For more info on Vanessa and Dzl's project visit www.illutron.dk.

Are you up for a challenge?



Industry guru Forrest M. Mims III has created a stumper. Video game designer Bob Wheels needed an inexpensive, counter-clockwise rotation detector for a radio-controlled car that could withstand the busy hands of a teenaged game player and endure lots of punishment. Can you figure out what's missing? Go to www.Jameco.com/untangle to see if you are correct and while you are there, sign-up for our free full color catalog.

JAMECO®
ELECTRONICS
1-800-831-4242

60 MHz - 1 GHz
Starting from $1,000

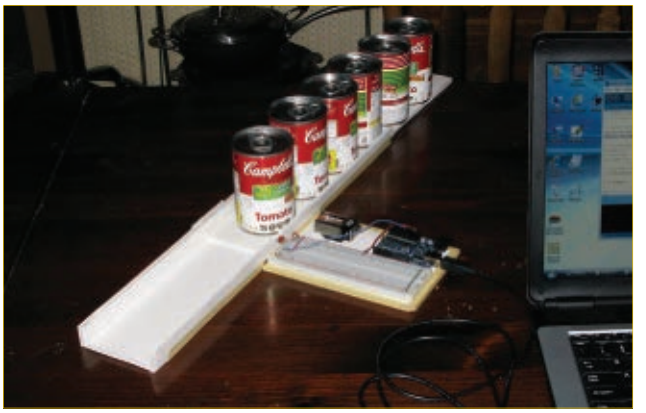
Experience the New LeCroy Oscilloscopes

Debug, verify, characterize, troubleshoot, analyze — oscilloscopes do it all, but LeCroy's breakthrough oscilloscopes do more. More measurements, more math, and more time-saving tools to easily make measurements in even the most challenging situations.

LeCroy

To learn more about LeCroy's full line of oscilloscopes, including the 30 GHz WaveMaster 8 Zi, the world's fastest real-time oscilloscope, visit www.lecroy.com or call 1-800-5-LeCroy

Page 40



Page 18

Projects & Features

34 USB MP Controller
This 'Recycled Electronics' build uses a knob from a VCR to create a controller for the Windows Media Player.
By Rob Caruso

36 Retractable Micro-Probe for Fine-Pitch IC Access
Size matters when you're working with surface-mount components. This handy device will get you right to the point of things.
By Dave Siegel

40 The Green Standby
This awesome unit lets your appliances stay connected to the grid while cutting the costs of your electric bills at the same time.
By Carlos Cossio

46 Experiments with Alternative Energy
Learn the fundamentals of renewable energy through this educational series. This month: Build a Solar Powered Battery Charger.
By John Gavlik

Departments

08	DEVELOPING PERSPECTIVES	66	ELECTRO-NET
10	READER FEEDBACK	72	NV WEBSTORE
31	NEW PRODUCTS	76	CLASSIFIEDS
32	SHOWCASE	78	TECH FORUM
		81	AD INDEX

Columns

12 TechKnowledgey 2009
Events, Advances, and News
Topics covered include iPOD recording device, repulsive light force discovered, protecting personal data, China to dump Lenova holdings, plus other stuff.

15 Open Communication
The Latest in Networking and Wireless Technologies
E-books offer one more way to communicate electronically.

18 Smiley's Workshop
An AVR C Programming Series
Infrared object detection meets tomato soup cans.

26 Q & A
Reader Questions Answered Here
Game show lockout circuit, fluorescent ballast, PICAXE or PIC, plus more.

52 Personal Robotics
Understanding, Designing & Constructing Robots
The Halloween Prop Dropper.

60 The Design Cycle
Advanced Techniques for Design Engineers
Uncloaking a 16-bit USB front end for the new ENC624J600 stand-alone 10/100 Ethernet controller.

67 PICAXE Primer
Sharpening Your Tools of Creativity
Using the AXE027 USB programming cable.

Nuts & Volts (ISSN 1528-9885/CDN Pub Agree #40702530) is published monthly for $26.95 per year by T & L Publications, Inc., 430 Princeland Court, Corona, CA 92879. PERIODICALS POSTAGE PAID AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: Send address changes to **Nuts & Volts, P.O. Box 15277, North Hollywood, CA 91615** or Station A, P.O. Box 54, Windsor ON N9A 6J5; cpcreturns@nutsvolts.com.

A Low Cost Solution for

Industrial Serial to Ethernet

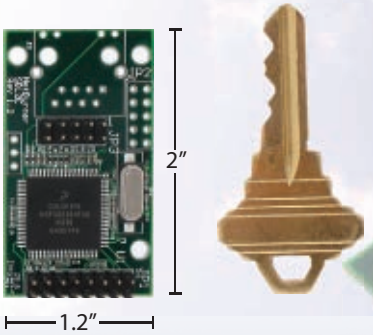
with Digital I/O and Analog to Digital Converters

Hardware Features

- Two TTL serial ports
- 10/100 Mbps Ethernet
- Up to 10 digital I/O
- Four 12-bit A/D converters
- Operating temperature -40 to 85 C
- Dimenstions: 1.2″ x 2″
- 32-bit performance

Software Features

- No programming required
- TCP / UDP / Telnet / HTTP modes
- DHCP / static IP support
- Web-based configuration



$19.95
Qty. 1000

The all-new

NetBurner SBL2e

INDUSTRIAL SERIAL TO ETHERNET SOLUTION

A NetBurner Complete Hardware & Software Solution

NetBurner

Board Part Number | SBL2e-200IR
Information and Sales | sales@netburner.com
Web | www.netburner.com
Telephone | 1-800-695-6828

freescale
Alliance Member

by Bryan Bergeron, Editor

DEVELOPING PERSPECTIVES

Designing with Efficiency in Mind

It's difficult to ignore the 'go green' mantra that's sweeping through the media and permeating virtually every industry. The way I see it, most of the activity is focused on marketing and printing consumer-friendly green stickers that proclaim enhanced efficiency of sorts for the same old products. Even so, it is time for us to take responsibility for our carbon footprint by using what we have more intelligently, by buying more efficient products in the first place, and — for electronics enthusiasts — by designing with efficiency in mind.

Changing behavior requires data — what better excuse for me to buy one of those energy monitors I've been eyeing for months (see **photo**). Prior to this purchase, I used a short extension chord with the outer insulating jacket removed and a clamp-on current meter around the hot lead to determine current flow. However, the new energy use meters are much easer. Not only do they perform the power factor corrections, they can even calculate operating cost in dollars and cents. I've been a long-time user of CF lighting, but never achieved the activation energy required to test all the electrical devices in my home or workshop. With my new meter, moving from appliance to appliance and from device to device was an education in energy use. Some of the older equipment in my shop has a better energy profile than the new equipment — especially older 120 VAC test equipment with an on-off switch. The low voltage wall transformers that power my new instruments consume energy just sitting there.

One of the biggest hits to my wallet turned out to be a large, rack mounted UPS. Before testing the power consumption at idle, I never considered the operating cost. However, at 200W, 24x7, the UPS turns out to be one of the most expensive pieces of equipment in my workshop.

PCBCORE

China PCB Supplier

(Prototype thru Production)

- ✓ 1-layer up to 30-layer
- ✓ Cost and quality
- ✓ On time delivery
- ✓ Dedicated service
- ✓ Instant Online Quote & Order

. . . . . Day and Night

No minimum quantity – 1 piece is welcome

Check our low price and save big $$$...

86(571)86795686 sales@pcbcore.com

www.pcbcore.com

Another surprise was my desktop computer. Turning on my screen saver adds an additional 40W load to my PC's power supply. Leaving the self-powered speakers on while the computer is off — a 20W hit. Laser printer on standby — another 20W. A power strip full of wall transformers idling away — 25W. Copy machine on standby — 20W. As you can see, energy use adds up quickly.

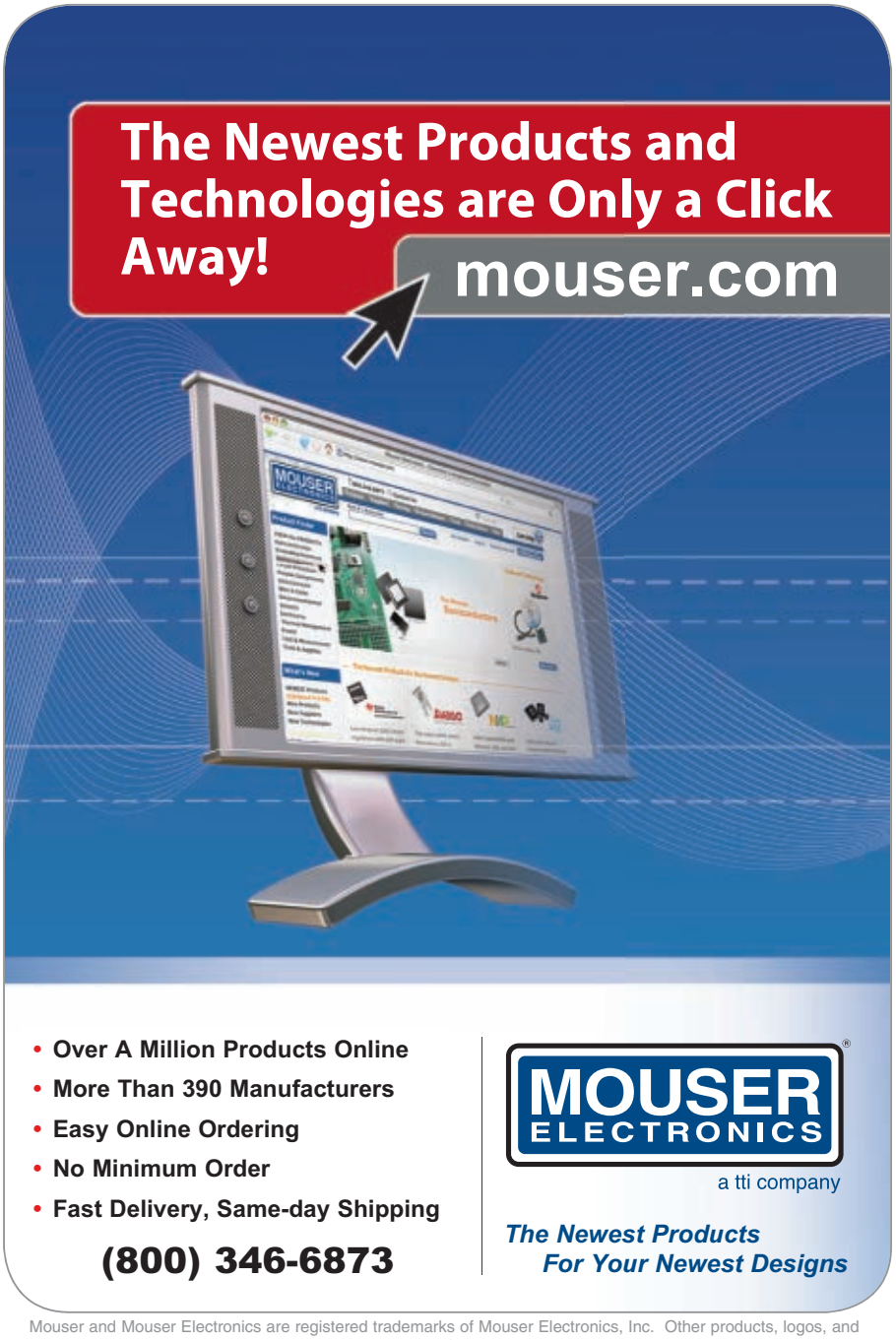
However, unless you're energy conscious when you purchase that new video card or rack-mounted power supply, you might be leaving out an important variable in your purchase decision: operating cost. Wouldn't it be great for manufacturers to list, for example, relative energy consumption for hard drives? Just how much extra does it cost to run one of those 9,600 RPM drives versus a 10,000 RPM model?

Another area highlighted by my time with the energy use meter is how little forethought I've given to the operating cost of the various devices that I've designed and built. For example, in deciding between an inefficient single-chip linear supply and a more efficient switched supply, my thoughts have been on heat production, space requirements, noise generation, ancillary component needs, and — of course — initial cost. I've never considered long-term energy consumption to determine which power supply design makes the most economic sense.

Here are some examples of energy design questions that you might consider in your next project:

- If your project includes a fan, do you plan to run it constantly or only when needed?
- Does the design for your new device have an auto shutdown feature so that it shuts down after a preset time has passed without activity?
- Do you really need a string of super jumbo LEDs on the front panel of your new project, or will a small, energy-efficient LED do the job?
- If your circuit includes a communications transmitter, is the power output the minimum needed for reliable communications?
- If your design includes mechanical linkages and motors (think robot), and it's intended for constant use, are the materials as light as possible? Are the motors high efficiency or simply the least expensive to purchase?

Although it's a good idea to consider energy efficiency in the design stage of all of your electronics projects, I'm not suggesting you double the cost of your next project that's going to spend most of its time sitting unused on the shelf. I'm talking about devices that you plan to use frequently. As an aside, if you're thinking of purchasing an energy meter, go in with a friend or two. Once you know the energy needs of your equipment and appliances, there isn't much need for constant monitoring. And you can always go with the split power cable if you have a clamp probe for your ammeter. The point is to get into the habit of using energy consumption as a factor in your component selection and electronics design decision-making process. **NV**



Mouser and Mouser Electronics are registered trademarks of Mouser Electronics, Inc. Other products, logos, and company names mentioned herein, may be trademarks of their respective owners.

READER FEEDBACK

TACHful FEEDBACK

I've been reading *NV* occasionally for some time now. I finally got around to subscribing to your fine mag in the last week or two. The first time I bought it you had an article about making a digital tachometer from 7490 counters, etc. That caught my eye because about 20 years ago I designed and built a tach very much like it. There were differences in how we did the math, but the units were very similar. Mine just had one or two wraps of wire around the coil wire and a small amplifier feeding a 556 timer (for clean pulses) instead of the diskette drive pickup the author used. The other timer in the 556 was how I did the math part, counting the pulses on the tens counter first for two seconds gave me the avg rpm's for a six cylinder; 1.5 seconds for a V8; and three seconds for a four cylinder. This count was entered into an array or flip-flops as a memory just before the counters were reset. I think your author used a multiplexer, but I'm not sure what that is.

Now you guys have me interested in PICs. I wish we had them back then ... I could have saved a lot of work. Maybe I'll make another tach when I get the time, but it will be PIC based. I can't believe how easy those little chips are to use. You've got me tinkering again.

Fred McNeil

TUNED IN TO ANTENNAS

I noticed Russ' answer to the "Antenna Question" in the Sept 09 Q & A regarding AM antennas and thought I might add something. If you take an example of an AM station broadcasting at 1,000 kHz about in the middle of the band, the wave length is about 980 ft. A quarter wave length is about 245 ft. A dipole antenna would have two elements about 245 ft long. (The "about" comes from small correction factors which are probably not greater than 10%.) Now an AM transmitting tower is one of the dipole elements. It is insulated from the ground and driven by the power generated by the final amplifier of the transmitter station. The other element is the image created by the ground plane. I would not be surprised if they lay conductors out on the ground to insure a really good ground plane. With this kind of setup, you know the radiated signal will have vertical polarization; that is the radiated electric field oscillates up and down and the accompanying magnetic field will oscillate horizontally and perpendicular to a line going back to the transmitting antenna.

The best receiving antenna would be a vertical wire 245 ft long. That's clearly not possible. But the longer the vertical antenna, the better.

The other way is to utilize the magnetic field. I used to have an AM antenna that had a horizontal ferrite bar about an inch in diameter and was about six inches long. It had a lot of turns of wire that not only picked up a signal but was part of a capacitor tuned circuit. You not only had to swivel the ferrite bar so it was perpendicular to a line back to the transmitting antenna, but you had to tune the capacitor to achieve resonance for the station frequency.

FM stations have a wavelength about a 100 times smaller, so a transmitting antenna is much smaller. The towers for FM just serve to hold the transmitting antenna up high for line-of-sight transmission. A 90 degree phase shift feeds horizontal and vertical elements in such a way that circular polarization ensues for the transmitted wave. Consequently, it doesn't matter if you pick up the signal with a vertical or a horizontal conductor as long as in the case of a horizontal conductor it is perpendicular to a line going back to the transmitting antenna.

There was a company (C. Crane Company) that specialized in AM radios. If they are still in business, they might be a source of sensitive AM receivers. Well I hope I haven't bored you to death.

Dean Kaul

Thanks for writing, Dean; I knew most of that except about C Crane Company. I didn't want to use up column inches to expound on that question.

Russ Kincaid

Continued on page 77

NUTS AND VOLTS
EVERYTHING FOR ELECTRONICS

Published Monthly By
T & L Publications, Inc.
430 Princeland Ct.
Corona, CA 92879-1300
(951) 371-8497
FAX **(951) 371-3052**
Webstore orders only **1-800-783-4624**
www.nutsvolts.com

Subscriptions
Toll Free **1-877-525-2539**
Outside US **1-818-487-4545**
P.O. Box 15277
North Hollywood, CA 91615

FOUNDER/ASSOCIATE PUBLISHER
Jack Lemieux

PUBLISHER
Larry Lemieux
publisher@nutsvolts.com

ASSOCIATE PUBLISHER/ VP OF SALES/MARKETING
Robin Lemieux
display@nutsvolts.com

EDITOR
Bryan Bergeron
techedit-nutsvolts@yahoo.com

CONTRIBUTING EDITORS
Jeff Eckert
Vern Graner
Joe Pardue
Ron Hackett
Rob Caruso
Carlos Cossio
Russ Kincaid
Fred Eady
John Gavlik
Louis Frenzel
Dave Siegel

CIRCULATION DIRECTOR
Tracy Kerley
subscribe@nutsvolts.com

SHOW COORDINATOR
Audrey Lemieux

MARKETING COORDINATOR WEBSTORE
Brian Kirkpatrick
sales@nutsvolts.com

WEB CONTENT
Michael Kaudze
website@nutsvolts.com

ADMINISTRATIVE ASSISTANT
Debbie Stauffacher

PRODUCTION/GRAPHICS
Shannon Christensen

Copyright © 2009 by T & L Publications, Inc.
All Rights Reserved
All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints, or typographical errors. *Nuts & Volts Magazine* assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in *Nuts & Volts*. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action, or expense arising from advertising placed in *Nuts & Volts*. Please send all editorial correspondence, UPS, overnight mail, and artwork to: **430 Princeland Court, Corona, CA 92879**.

Printed in the USA on SFI & FSC stock.

THE ORIGINAL SINCE 1994
PCB-POOL®
Beta LAYOUT
Servicing your complete PCB prototype needs :
• Low Cost - High Quality PCB Prototypes
• Easy online Ordering
• Full DRC included
• Lead-times from 24 hrs NEW !
• Optional Chemical Tin finish no extra cost NEW !
Watch "ur" PCB® Follow the production of your PCB in REALTIME
FREE LASER STENCIL WITH ALL PROTOTYPE PCB-ORDERS
email : sales@pcb-pool.com
Toll Free USA : 1 877 390 8541
www.pcb-pool.com
Beta LAYOUT

RF Specialists
RF Modules
From Part 15 to Part 90 Compliant
Narrow Band FM, UHF Multi-Channel
GSM/GPRS
M2M Solutions
GSM/GPRS modules and modem series
Industrial Bluetooth
OEM, Modules, Wireless Device Servers, RS-232
Long range options, low cost
Data Loggers
Stand Alone and
Wireless Mesh Networking Logger
GPS
OEM Modules and USB ZigBee Sticks,
Mesh Networks
ZigBee Pro
OEM Modules and USB ZigBee Sticks,
Mesh Networks
Wi-Fi
RS232 / 422 / 485 to Wi-Fi Adapter
Connect Data Acquisition Equipment through Serial Port to Wi-Fi network
LEMOS INTERNATIONAL
www.lemosint.com
866.345.3667
sales@lemosint.com

Lynxmotion
The Lynxmotion Servo Erector Set
Imagine it... Build it... Control it!
With our popular Servo Erector Set you can easily build and control the robot of your dreams. Our interchangeable aluminum brackets make the ultimate precision mechanical assemblies. Our Visual Sequencer for SSC-32 provides powerful PC, Atom, or BS2 based control.
Visit our huge website to see our complete line of aluminum and Lexan based robot kits, electronics, and mechanical components.
Biped BRATs
Johnny 5
Round 3DOF Hex
A4WD1
Bipeds
Mini 2DOF Hex
AL5C Arm
www.lynxmotion.com
Toll Free: 866-512-1024
Images represent a fraction of what can be made!
The SES now has 143 unique components!

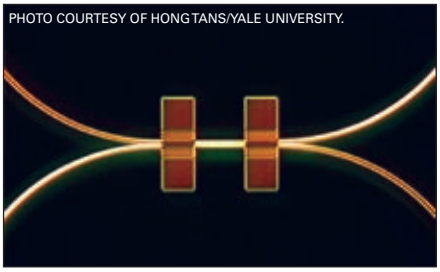
TECH KNOWLEDGEY 2009

EVENTS, ADVANCES, AND NEWS

■ BY JEFF ECKERT

ADVANCED TECHNOLOGY

REPULSIVE LIGHT FORCE DISCOVERED



■ Interacting lightwaves can be used to control devices on a silicon chip.

Back in July, a team of Yale University (**www.yale.edu**) researchers announced the discovery of a curious "repulsive light force." No, we're not talking about emanations from the Lifetime Channel. It's actually a physical phenomenon that can be used to push things like tiny mechanical switches on micro- and nano-scale electrical systems. As it happens, this is the team's yang discovery, having previously discovered the yin of its attractive complement.

The forces are different from light's radiation pressure, which pushes in the direction the light travels. Instead, these push or pull in perpendicular directions. The team had already used the pull force to open a nanoscale switch but couldn't close it again by pushing in the opposite direction. But by using both forces, they now can manipulate components in both directions.

To create the repulsive force on a silicon chip, the team split an infrared beam into two separate beams and forced each one to travel a different length of silicon nanowire (i.e., a waveguide). As a result, the two light beams became out of phase, creating a repulsive force whose intensity can be controlled: the more out of phase the beams are, the stronger the force.

"These light forces may one day control telecommunications devices that would require far less power but would be much faster than today's conventional counterparts," according to Prof. Hong Tang. "An added benefit of using light rather than electricity is that it can be routed through a circuit with almost no interference in signal, and it eliminates the need to lay down large numbers of electrical wires."

MICROCHIP HANDLES 1,000 CHEMICAL REACTIONS SIMULTANEOUSLY

■ This device allows 1,000+ chemical reactions on a postage stamp size, PC-controlled microchip.

Another recent discovery with perhaps more imminent practical application is a microchip technology that UCLA (**www.ucla.edu**) researchers claim could replace flasks, beakers, and hot plates in chemistry labs. A collaboration of chemists, biologists, and engineers has produced a chip technology — based on microfluidics — which is defined as "the utilization of miniaturized devices to automatically handle and channel tiny amounts of liquids and chemicals invisible to the eye."

In a demonstration, the team performed chemical reactions using "in situ click chemistry," in which reactive molecular building blocks are designed to "click" together selectively and covalently. The technique is often used to identify potential drug molecules that bind tightly to protein enzymes to either activate or inhibit an effect in a cell. According to the group's report, "While, traditionally, only a few chemical reactions could be produced on a chip, the research team pioneered a way to instigate multiple reactions, thus offering a new method to quickly screen which drug molecules may work most effectively with a targeted protein enzyme. In this study, scientists produced a chip capable of conducting 1,024 reactions simultaneously, which, in a test system, ably identified potent inhibitors to the enzyme bovine carbonic anhydrase."

The next step for the team is to look into applying the technology to other screening reactions in which there are limited amounts of chemicals and material samples, e.g., with protein enzymes called kinases which are involved in the malignant transformation of cancer. In time, the concept may open up many new areas for biological and medicinal studies.

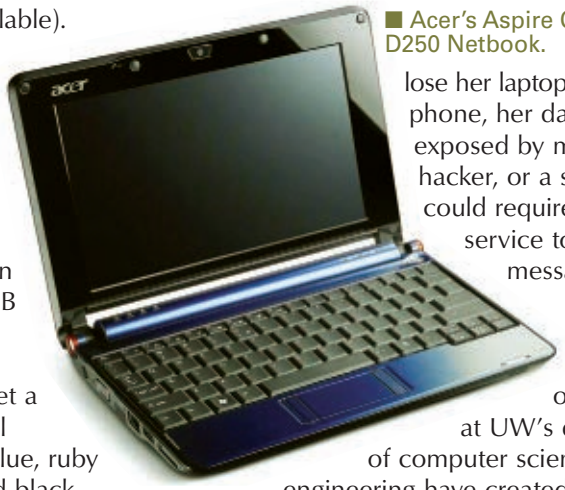
COMPUTERS AND NETWORKING

$300 NETBOOK INTRODUCED

The latest entry in the netbook market from Acer, Inc. (**www.acer.com**), is the Aspire One D250 which sneaks in under the $300 wire on most Internet stores. Its main claims to fame include a 10.1-inch CrystalBrite™ backlit LED display with 1024 x 600 pixel resolution, integrated webcam and microphone, and a fighting weight of only 1.11 kg (2.4 lb). It also includes a multigesture touchpad, an 802.11b/g WiFi connection, and Fast Ethernet (Bluetooth and 3G

wireless also available).

The D250 is powered by an Intel Atom processor and a Mobile Intel 945GSE Express or 82801GBM chipset, and it can handle up to 2 GB of DDR memory. And for the style conscious, you get a choice of seashell white, sapphire blue, ruby red, and diamond black cases. As an aside, while worldwide PC shipments declined by about 5% in Q2 of this year, Acer bucked the trend and, in fact, has racked up a 34% gain this year over last. They must be doing something right.



■ Acer's Aspire One D250 Netbook.

PROTECTING PERSONAL DATA

When you talk to someone on the phone, the conversation generally is not recorded and therefore disappears when you hang up, unlike email and other files sent over the Internet. As many of us have learned the hard way, these things can last forever and come back to haunt us at any time. As noted by University of Washington (**www.washington.edu**) doctoral student Roxana Geambasu, "When you send out a sensitive email to a few friends, you have no idea where that email is going to end up. For instance, your friend could lose her laptop or cell phone, her data could be exposed by malware or a hacker, or a subpoena could require your email service to reveal your messages."

But Geambasu and some other students at UW's department of computer science and engineering have created a prototype system called "Vanish" that can place a time limit on text uploaded to any Web service through a browser — essentially making it self-destruct over time. The process is a little complex to cover here, but it basically "washes away" data using the natural turnover (called "churn") on peer-to-peer networks.

It's still in the prototype stage, but you can read the documentation and even download it from **vanish.cs.washington.edu**. You just need to have Java 5 or higher and Firefox on your machine. Vanish has been successfully tested on Fedora Core 7, Ubuntu Jaunty, Mac OS X 10.4+, Windows XP, and Windows 7, and it will probably work on other platforms, as well.

MULTI-TERABYTE TAPE

For most of us, tape drives seem about as modern as wringer washing machines, but tape backup — at less than $0.04 per gigabyte — still offers a significant cost advantage over other storage systems. The present standard is the Ultrium LTO-4 format, defined and licensed by the Linear Open Tape consortium of drive manufacturers HP, IBM, and Quantum (**www.trustlto.com**). LTO-4 tapes have a raw (native) capacity of 800 GB, but a new version — appropriately dubbed LTO-5 — will offer 1.6 TB native and 3.2 TB compressed.

Media manufacturer Imation (**www.imation.com**) recently announced that it will be introducing the next-generation LTO-5 cartridges early next year. The tape uses metal particulate media and employs Imation's proprietary TeraAngstrom™ technology which produces a significantly smoother surface and a high signal-to-noise ratio (SNR) to deliver reduced errors and faster transfer rates. Compressed data transfer rates run up to 360 MB/second — a significant improvement over previous tape generations.

At present, Imation is the only company licensed to manufacture the new tape format, although FujiFilm has at least tentative plans to join in. The interesting thing is that we couldn't locate anyone who can sell you a LTO-5 drive or has announced a specific product. But presumably at least one of the big three (or competitor Tandberg) will come up with something. Notably, there is already a roadmap to LTO-6

INDUSTRY AND THE PROFESSION

CHINA TO DUMP LENOVA HOLDINGS

It was only back in 2005 that Lenovo completed its acquisition of the IBM Personal Computing Division, thereby becoming the third largest PC company in the world. But according to the IDG News Service, the government's Chinese Academy of Sciences (which now owns 65% of the parent company), Legend Holdings, wants to sell a 29% share in the company. Lenovo declined to comment on the report, but the divestiture offer is likely based on sinking enterprise sales in the West. If you're looking for a unique investment opportunity, all you have to do is come up with a paltry $404 million.

WIND POWER REPORT AVAILABLE

The US Department of Energy recently released a report generated by its Lawrence Livermore National Laboratory (**www.llnl.gov**) revealing, among other things, that the USA has been home to the fastest-growing wind power market in the world for four years in a row. US wind power capacity installations increased by 60 percent in 2008, representing a $16 billion investment in new projects. "At this pace, wind is on a path to becoming a significant contributor to the US power mix," noted the report's author, Ryan Wiser.

Wind projects accounted for 42% of all new electric generating capacity added in 2008, and wind now delivers nearly 2% of the nation's electricity supply. For a free copy of the report in PDF form, you can log onto **www.jkeckert.com/downloads.html** and hit the appropriate link.

— a 3.2 TB format — on the drawing boards, but with the future of the tape drive market being somewhat questionable, no one is sure it will ever appear.

ARE YOU AN IDIOT OR WHAT?

One would think that all Internet users — having been pummeled for years by spam and viruses — would have learned something. But according to a report by the Messaging Anti-Abuse Working Group (MAAWG), almost a third of surveyed consumers admitted to responding to a message they believed to be spam, and 80 percent doubted that their PCs were at risk of ever being infected by a "bot." The report is based on 800 interviews with users in the United States and Canada who are not security experts and whose email addresses are not managed by a professional IT department.

To download the depressing report, visit **www.maawg.org** and click on the "MAAWG Consumer Survey..." links. The MAAWG general meeting, by the way, will take place Oct. 26-28 in Philadelphia, so if you are interested and don't mind the $400 registration fee, you might want to check it out.

CIRCUITS AND DEVICES

CAMERA FEATURES ULTRA-WIDE-ANGLE LENS

There is no shortage of choices if you're looking for a digital camera, but you might want to consider the new LUMIX DMC-ZR1 from Panasonic, especially if you like wide-angle shots but also want a long-range zoom. This 12.1 MP unit features "the world's first 0.3 mm thin aspherical lens" which allows the body to remain compact while providing an optical zoom range of 25-200 mm.

Other features include high-speed autofocus, a 2.7 inch LCD screen, an optical image stabilizer, and the other usual niceties. And, yes, you can choose among black, red, blue, and silver. Suggested retail price is $279.95.

■ The Panasonic LUMIX DMC-ZR1 sports a Leica DC Vario-Elmar lens, providing a 25-200 mm zoom range.

iPOD RECORDING DEVICE

There is also no shortage of iPod accessories, but a pretty neat one is Mikey from Blue Microphones (**www.bluemic.com**). Mikey essentially turns the iPod into a recording device so you can capture lectures, live music, and pretty much any form of audio presentation. It is built around Blue's stereo condenser capsules and features three-position user-selectable gain settings, a speaker for playback, and a 180° pivoting mike head that can be set in a variety of positions for optimal recording. You can also choose from three sensitivity levels, so whether you use it to capture a Metallica concert or a poetry reading at Barnes & Noble, you're covered.

■ Meet Mikey, an iPod add-on for audio recording.

According to Blue Mic, it requires no software installation and will record continuously for up to four hours. Musicians may want to note that Mikey can record and store up to four tracks, which can then be mixed down to allow even more tracks.

As of this writing, detailed technical specs were essentially nonexistent, with neither the company's website nor the Mikey manual providing even rudimentary data such as frequency range. But for $79.99, you can't go far wrong. **NV**

■ BY LOUIS E. FRENZEL W5LEF

E-BOOKS:
Sophisticated electronics let you read a new way.

When you think about reading, your mind usually pictures a book, newspaper, or magazine. Although these days, you may think of reading from your PC or laptop screen. Now there is another choice. It's called an e-book reader (or e-reader for short). It is literally a book-sized device with a large LCD screen, lots of storage for text, and a way to navigate through it. Such devices are becoming more practical and affordable, and seem destined to replace at least some printed material in the years to come. The e-book reader is just one more example of electronics bringing you new ways to "communicate."

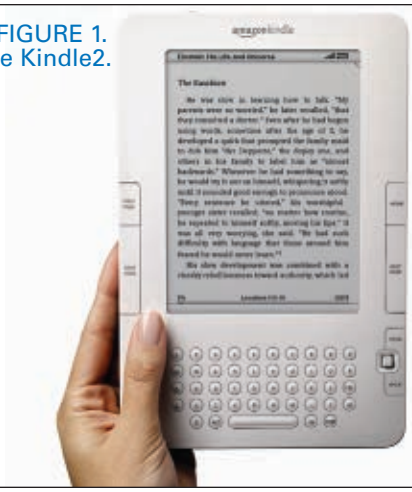
Companies have been trying to produce a suitable e-book reader for years. None have been practical or affordable, and worst still people didn't really enjoy the reading experience. However, the latest technology now makes it possible to create a truly desirable e-book reader. Probably the best example is Amazon's Kindle (see **Figure 1**). The first generation unit came out in 2007 and was a big hit. Amazon's second generation device called the Kindle2 is an even bigger hit. I bought one recently and for the first time I see that such a device is highly useable. It is also innovative.

The Kindle2 is about the size of a large paperback book at 5.5 x 8 inches. The six inch (diagonal) screen is a high contrast black on white LCD. The device is one of the thinnest electronic products I have ever seen and it is very light — lighter than most of the books you might read. The Kindle2 also has a huge 2 GB Flash memory to store books, magazines, and newspapers. Amazon claims you can store up to 1,500 books. (That ought to be enough for a long time!) I regularly read about 60 books per year, so in about 25 years the memory will be full.

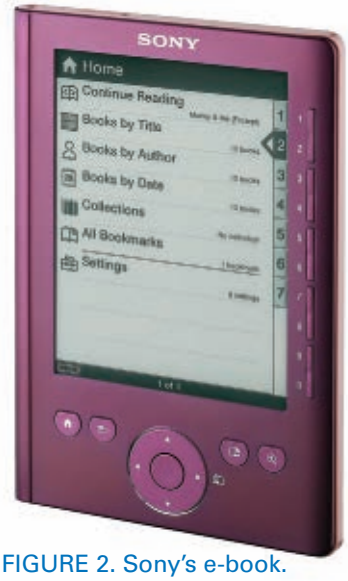
The controls are pretty easy to use. There are pushbuttons for next page, previous page, menu, home, back, and a navigation scroll button. A full keyboard is also provided with a search function. You can even change the font size to fit your eyeballs. If you are not a good reader, the Kindle has a text to voice output. Just plug in your headset and let the device read to you (like an audio book if you like those).

The coolest feature of the Kindle2 is the built-in cell phone. You don't use it to make calls and there is no monthly phone bill to worry about. It is a dedicated Sprint connection back to Amazon, so the phone lets you review and buy books directly. I have already bought five books this way. They download in under a minute. (Talk about convenient!) The good news is that e-books are much cheaper than print books simply because there is no paper or printing involved. Most current best-seller books cost approx. $9.95 vs. the $20 to $27 of a printed version and many books are free. The price of the Kindle2 is about the only downside of this innovative product. At $359, you need to read a lot of books, but I suspect my unit will pay for itself in less than a year.

■ FIGURE 1. The Kindle2.



As for the actual reading experience, it is fine. I thought I would have to go through an adaptive process to get used to reading from a screen, but I didn't. I actually hate reading from a computer screen but the Kindle2 is as close to a printed book as you will probably get electronically. There are hundreds of thousands of book choices to choose already,



■ FIGURE 2. Sony's e-book.

and lots more to come.

WHAT'S INSIDE?

Just like most electronic products today, the Kindle's the core of the design is an embedded controller. Kindle uses a Freescale multimedia processor based on the ARM11. This microcontroller has a ROM that contains the reading control program and LCD screen manipulation software. It also has a 2 GB Flash EEPROM where the text is stored. In the case of the Kindle2, it has a full cdma2000 data cell phone. It is a 3G cell phone with EV DO Rev A compatibility, with a fall-back to the slower 1xRTT technology if the 3G is not available. The battery is a thin lithium-ion (with charger). It is good for four days of reading, or up to two weeks if you turn off the cell phone.

The real secret to the Kindle2's success and viability is the screen. It is made by a company called E-Ink. They have found a way to make a low cost and very low power LCD screen that does not need a white backlight. It has super contrast and 16 levels of gray. The backlight, of course, is what burns up so much battery power in other LCD screens, and some say the bright backlight is what causes eye strain when reading from a PC or laptop. Most of the new e-book readers use the E-Ink display since there is nothing else like it.

Incidentally, Amazon has a newer model called the DX that has all the same features of the Kindle2 but with a much larger 9.7 inch screen. This model is designed to better display newspapers, magazines, and college text books. The DX model will also display PDF documents so it has potential as a business tool. It also has a larger memory that can hold up to 4,000 books, but at a cost of $489. Personally, I have never felt constrained by the six inch screen, but no doubt some content is better displayed all on one page without scrolling.

OTHER E-BOOKS

There are other e-book readers on the market from Sony, Plastic Logic, and iRex. However, none have been as successful as the Kindle. The Sony models definitely deserve consideration. Sony has an extensive line of e-book readers with prices from less than $200 to near $400. Their Reader Digital Book called the PRS-700 sells for $349 and has a six inch E-Ink screen like the Kindle. It has a 512 MB Flash memory to hold up to 350 average size books.

Sony's latest models are the Reader Pocket Edition (**Figure 2**) and the Reader Touch Edition. Both feature an E-Ink display and come in a variety of colors. The pocket edition has a five inch screen and sells for $199. It can store up to 350 books. The Touch version has a six inch touch screen that also lets you write on it with a stylus to annotate pages or highlight text. Its price is $299. Both products come with a protective sleeve and the USB cable for connecting to your PC so you can download books from Sony' eBook Store (which has hundreds of thousands of titles).

The iRex device called the iLiad is a high-end device with a 10.2 inch display. It is a touch screen with a 768 x 1,024 pixel resolution. The price is a whopping $859. This device lets you write on the screen to make notes or highlight text. It runs the Intel XScale processor and has a 256 MB Flash memory. Another feature is built-in stereo audio speakers or headphones. Instead of a cell phone inside, it uses Wi-Fi for wireless connection to a hot spot with 802.11b/g technology to download books. A 10/100 MHz Ethernet port is built in, as well.

Plastic Logic has a forthcoming reader called the eReader. It is not available yet but should be soon. It has a full 8.5 by 11 inch (14 inch diagonal) screen with touch screen manipulation. It will have wired and wireless communications capability. Look for it in early 2010.

Samsung also recently released an e-book reader for their Korean customers. The unit is not available in the US, but my guess is you can expect one in the near future. Even Apple is said to be working on some kind of e-book reader.

READ ON YOUR PHONE

We are putting everything else on our cell phones, so why not a book reader? There are already e-book reading software apps for the iPhone and iPod and the Blackberry. Barnes & Noble offers free reader software for the iPhone and Blackberry, and you can buy books online from its extensive collection.

I questioned this cell phone reading but after trying it out on my iPhone, I'm okay with it. In fact, it is better than I thought it would be.

WHERE YOU GET BOOKS

For E-book readers to be successful, there has to be a huge base of books to draw from. Publishers and the e-book reader companies are spending big bucks to make sure you never run out of things to read. Amazon claims they have 270,000 books available for the Kindles and new ones become available daily. They are categorized well and you can search for what you want. Sony also has a massive collection of over 500,000 books thanks to a deal with Google who has digitized a jillion books over the past several years.

Some publishers are rushing to get textbooks out for e-book readers.

For example, CourseSmart is a joint venture of McGraw-Hill, Pearson Education, and four other publishers who are offering students a rental or subscription to their books. You can rent for 30, 60, or 180 days after which access expires. Many colleges (and publishers) are currently testing the electronic textbook idea with somewhat mixed results from students. With high textbook prices and publishers losing money thanks to used book resales, I suspect the e-book will happen sooner rather than later.

Another source of e-books is Scribd — a website that lets you read documents online. It will have 5,000 plus titles available from Simon & Schuster. And don't forget Barnes & Noble. Google (now making their books available via Sony) is expected to announce a separate e-book store itself in the future. My guess is that there is roughly a million books available now with many more to come. I haven't seen any technical books yet, but hopefully we will see that in the future.

You can also get subscriptions to most of the major newspapers (Wall Street Journal, USA Today, etc.) and many magazines. Prices are a bit lower than the print version. The larger screen readers are probably better for these, but smaller readers do okay.

Basically, there is no shortage of stuff to read on an e-reader and the real tidal wave of material is yet to come.

An important thing to keep in mind is to be sure that the book you are downloading is compatible with your reader. There are several e-book file formats too numerous to discuss here. Some are proprietary and others open. Most online sources will clue you in about this to ensure a match with your reader.

FUTURE OR FAD?

If you are skeptical about electronic books, think of this. We communicate with photographs as much (if not more) as we do with text. Look what has happened to the photography and film business over the past 10 to 15 years. Film cameras have almost disappeared and finding film for that 35 mm SLR you spent a fortune on a while back is a nightmare. Now, you can now get a 10 or 12 megapixel camera for $100 or so. Plus, a high percentage of cell phones now contain a two or three megapixel camera.

My guess is that the same thing will happen with electronic books. Once the copyright, royalty, and distribution issues are resolved, we'll be able to get virtually any book in electronic form. You'll be able to carry your whole library around in an e-reader that's the size of a standard book. I like that scenario but I am a bit saddened at the thought of the loss of all those hard copy books.

I have a huge library now that won't just go away, but it looks like I won't be adding to it much in the future. **NV**

#15 SMILEY'S WORKSHOP

AVR MICROCONTROLLER: C PROGRAMMING - HARDWARE - PROJECTS

Infrared Object Detection

Follow along with this series! Joe's book & kits are available in our webstore at **www.nutsvolts.com**

by Joe Pardue

Recap

In recent Workshops, we've been using a new development board and components kit: the Arduino Duemilanove and the Arduino Projects Kit (available from *Nuts & Volts* and Smiley Micros). We recognized that The Arduino Way (TAW) is a very simple and easy way to begin using microcontrollers. And we learned that while TAW uses a C-like language, it does not (IMHO) provide a clear path to learning the C or AVR architecture — both of which are our long-term goals for this Workshop series. So, we were introduced to A C Way (ACW) that uses more standard (again IMHO) AVR tools. We decided to discuss projects using the kit with TAW, but also provide the software ACW in the Workshop zip file for those ready to move on. After we've introduced all the kit parts, we will then move exclusively to ACW since we will be looking at issues that are more difficult to accomplish with TAW (such as using timer interrupts).

Last month, we learned to measure light and temperature, and faked showing decimal numbers from data stored as integers. This month, we are going to learn about IR (infrared) object detection.

■ FIGURE 1. Cute L'il Bunny has her last thought.

But Is It Light?

In **Figure 1**, we see Cute L'il Bunny in the dark having her very last thought. What she doesn't know is that bad ol' Mr. Snake is a pit viper and has a couple of IR Object Detectors located in pits on either side of his head between his eyes and his nose. These sensors allow him to triangulate on objects that are hotter than the surrounding environment, such as bunnies that think they are well hidden in the dark but are actually glowing brightly to the snake. Yum.

William Herschel accidentally discovered infrared radiation in 1800. He used a prism to split sunlight into colors and placed thermometers along the spectrum to measure the temperatures of the colors. He was shocked to note that the hottest part occurred in the unlit area just below the visible red zone, which he named infrared (infra means below). [Incidentally, in 1781 he discovered Uranus, but I don't know if thermometers were involved.]

We cannot see IR with our eyes, but if the source is intense we can 'see' it with our skin as the perception of warmth. You can close your eyes tightly and find a nearby heater by holding your palms out and turning around until you feel the heat — this isn't exactly high resolution 'seeing' but it is 'perceiving' IR light.

You might think it would be cool if we could see IR with our eyes. Well, think about that for a moment. Since we operate at 98.6° F, we — like that poor bunny — are beacons of IR light and if we could see it we would be blinded by the emissions in our own eyeballs. Snakes can use IR because they are cold blooded. **Figure 2** shows a NASA thermoscan of a dog that — in addition to looking really creepy — provides a false color view at how the dog might appear to something that can see IR.

Even though you can't see IR with your own eyes, you can detect it with a digital camera. Just hold a TV remote

pointed at your camera (even a cellphone camera will show this) and press the power button. With your eyes you see nothing but as shown in **Figure 3**, the camera shows a light.

Some Common Uses For IR Sensors

One of our most common electronic IR emitters is, of course, on that blessing to couch potatoes everywhere: the TV remote control. It broadcasts a coded IR signal to the IR detector on the TV console that decodes the signal and saves you the excruciating drudgery of waddling over to the TV to change the channel.

And where would the military be without IR for target acquisition? Fire a Sidewinder missile (named after a pit viper) at the exhaust pipe of your enemy's jet and say good-bye to your little friend. Another cool way to improve your kill skill is with night vision goggles. This way you can be like Mr. Snake.

There are many other uses, such as on a factory production line that senses tomato soup cans passing on a conveyer belt. This is much more boring than blasting enemies (or eating bunnies), but that's the practical example we will construct by the end of this Workshop.

IR Reflective Object Sensor: The QRD1114

The Arduino Projects Kit has an IR Reflective Object Sensor (the QRD1114) that we will use for several projects. The QRD1114 is made from an IR LED emitter, an IR phototransistor detector, and an IR opaque shield that holds them together. You can remove the emitter and detector by holding the legs and pushing toward the front of the device. If you do this, remember which way the legs were so that you can get it reassembled properly. Also remember to watch for protruding beyond the shield, as this will radically affect the way the device works. The functional concept is simple: The shielded emitter radiates IR from the open end which can only be seen by the shielded detector if the IR bounces off something. This is shown in a cut-away view in **Figure 4**.

Making IR Visible

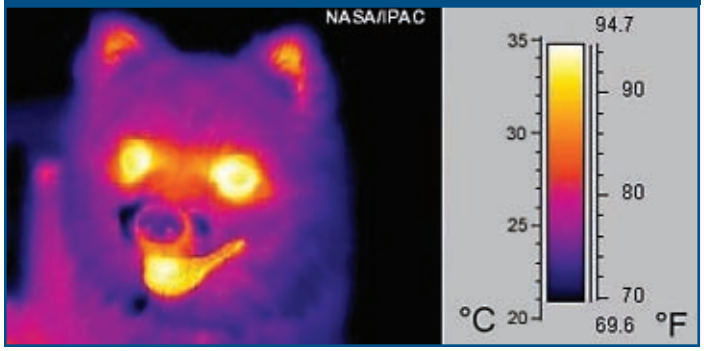
The QRD1114 must be calibrated to a specific application to be used to its greatest effect. Calibration is necessary for two main reasons: 1. The sensor detects IR not just from the reflections of the associated emitter, but from ambient (environmental) IR; and 2. The amount of IR reflected back from the emitter varies with the IR reflectivity of the reflecting object and the distance to that object.

IR Doesn't Know Black From White

White reflects all visible light and black absorbs it. You might think that a white area would reflect more IR back to the sensor than a black area. I did, but it turns out that the operative part of the definition of black and white is 'visible.' Some things that appear black and white to me reflect the same amount of IR and look identical to the IR sensor. I printed my first motor wheel encoder on photographic paper and my detector couldn't tell the difference in the white and black bars.

Naturally, I assumed that the problem was something in the software or hardware and spent a lot of time looking for a bug. It turns out that printing the same image on plain paper works pretty well. Apparently, the shiny surface of the photo paper is transparent to the human eye but reflects the incidental IR. I found that I got an even better sensor reading if I went over the plain paper printed black areas with a black Sharpie© ink pen. Again, I couldn't see much difference but the detector sure could.

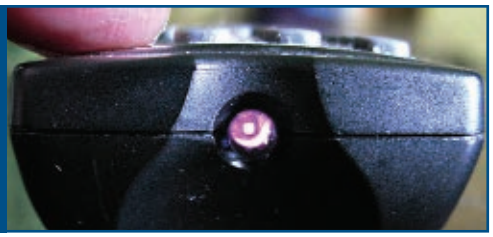
■ FIGURE 2. Dog IR thermoscan.



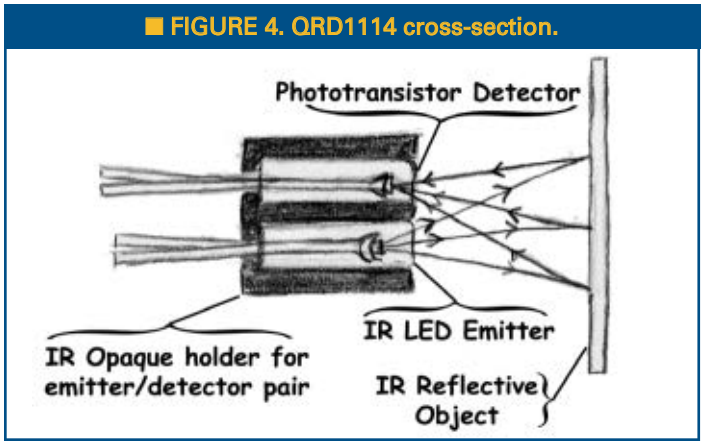
Breadboard: Show Invisible IR Intensity With Visible Red LED

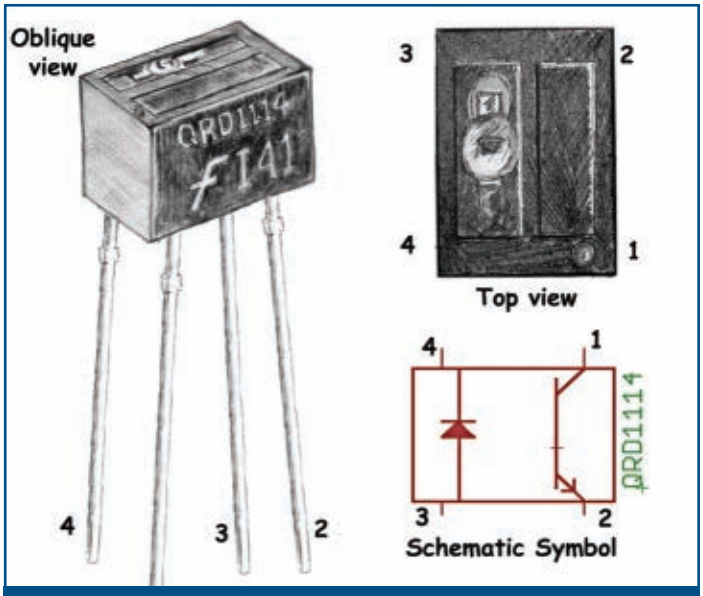
You can see a drawing of the QRD1114 along with its schematic symbol in **Figure 5**.

■ FIGURE 3. Digital camera 'sees' TV remote IR.

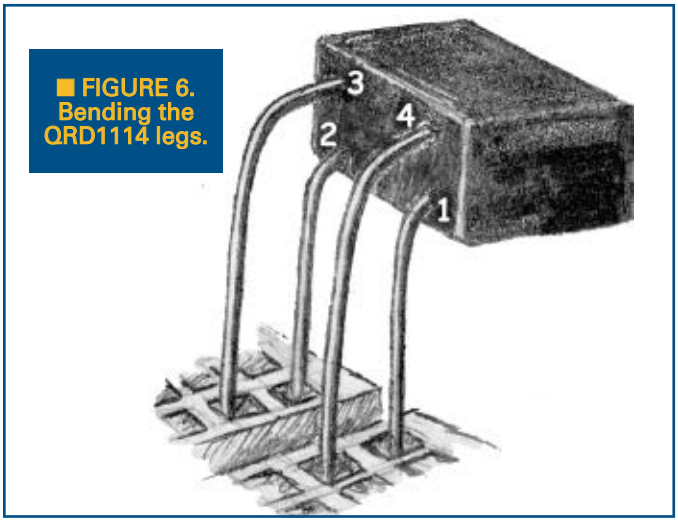


■ FIGURE 4. QRD1114 cross-section.





■ FIGURE 5.QRD1114 reflective object sensor.

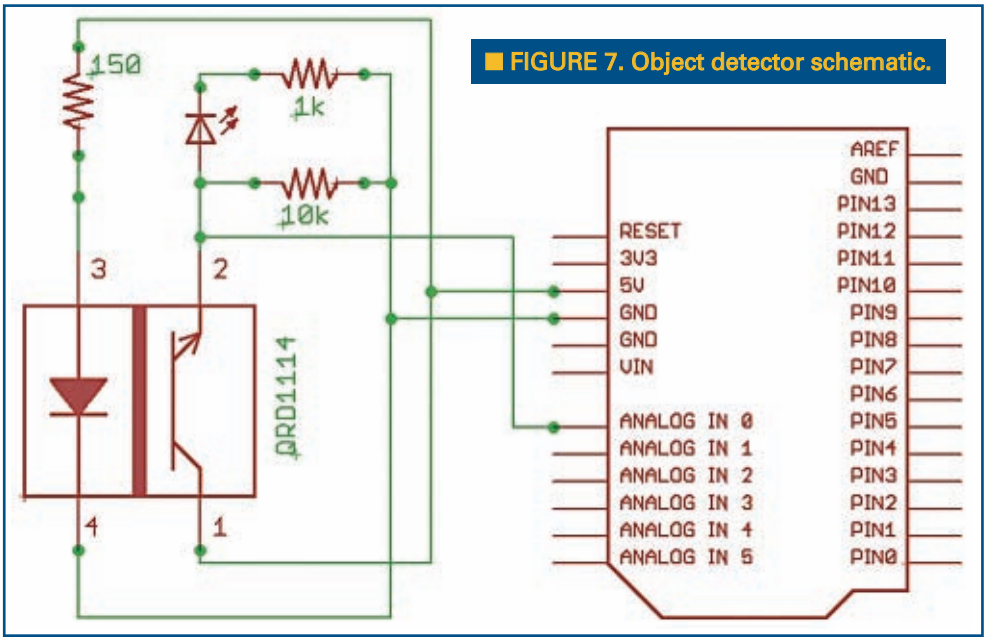


■ FIGURE 6. Bending the QRD1114 legs.

We are going to carefully bend the legs on the QRD1114, as shown in **Figure 6**, so that we can mount it on the end of the breadboard with it 'looking' to the horizontal. Be very careful when you bend these legs and even more careful when you trim them to fit in the breadboard. The legs will break if bent more than a couple of times so make sure you get it right the first time. It is very easy to lose track of which leg goes where and since you only get one of these in the kit, you don't want to screw this up. Bend the legs that go to the phototransistor straight down to the side and then bend the IR LED legs in the same direction, but make the bend a little over 0.1 inch from the bottom. Next, trim them so that they will fit in the breadboard with the face of the sensor at the edge of the breadboard (but not overlapping the foamcore base since that edge slides into the ALP box). The breadboard schematic is shown in **Figure 7** and the layout in **Figure 8**. **Figure 9** is a photo of the IR object detector.

As you can see from the schematic, a red LED has been inserted into the circuit that has its brightness controlled by the detector, providing us with a visible cue for the amount of IR being detected. The IR light falling on the phototransistor base provides the bias current that controls the collector emitter current that flows through the LED. You can move your finger back and forth in front of the sensor and the red LED will brighten or dim in response. This is a purely analog response and could — with proper amplification — be used to drive some other analog device such as a motor.

We can get a digital measure of this response by putting a 10 KW resistor from ground to the phototransistor and running a wire from that point to the Arduino ADC in analog input pin 0 as shown in the schematic. Let's apply this to a real-world experiment (and by 'real' I mean 'contrived').



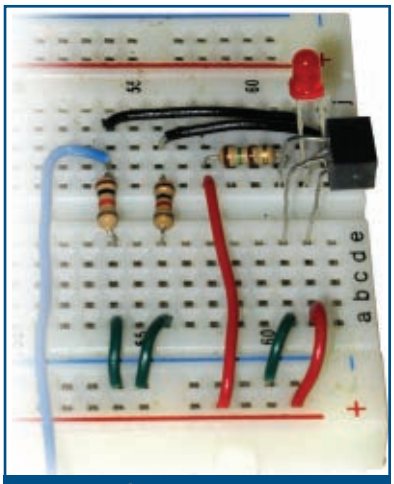
■ FIGURE 7. Object detector schematic.

Tomato Soup Can Counter

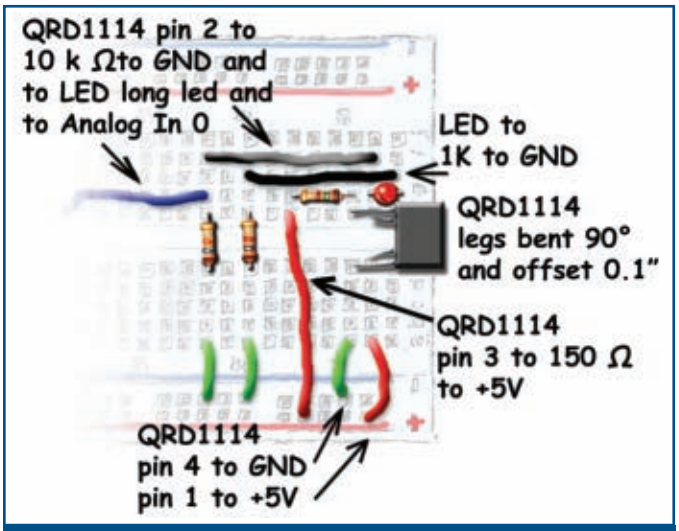
I went a little overboard when I did this experiment. I made a foamcore board 'conveyer belt' where I placed six Tomato soup cans (reduced sodium for a healthier experiment) and dragged them past the sensor to get calibration values. **Figure 10** shows the device in the starting position and after the cans have been conveyed past the sensor.

As for the construction details, I used foamcore board and masking tape, and eyeballed everything. So should you — it's a

prototype, so expect imperfections. The 'belt' should be a little wider than a soup can and long enough to hold six cans (which is the number I had in my pantry), while the 'base' should be just slightly wider than the belt so you can slide the cans past the QRD1114 as shown in the pictures. The IR detector should almost touch the soup cans as they pass by to get a good reflection.



■ FIGURE 9. IR object detector photo.



■ FIGURE 8. IR object detector layout.

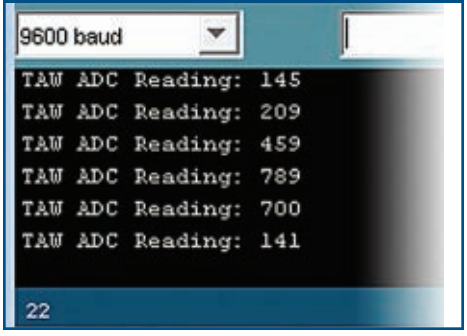
Tomato Soup Can Counter Software

You have no way to predict the ADC values for the IR returned from a particular object other than it will be between 0 and 1,023. I did preliminary tests using the ReadPot TAW source code in the Arduino IDE (from Smiley's Workshop 12) and substituting the detector for the potentiometer. The data shown in **Figure 11** varied from a low of 145 to a high of 799 for my finger (your finger will probably be different).

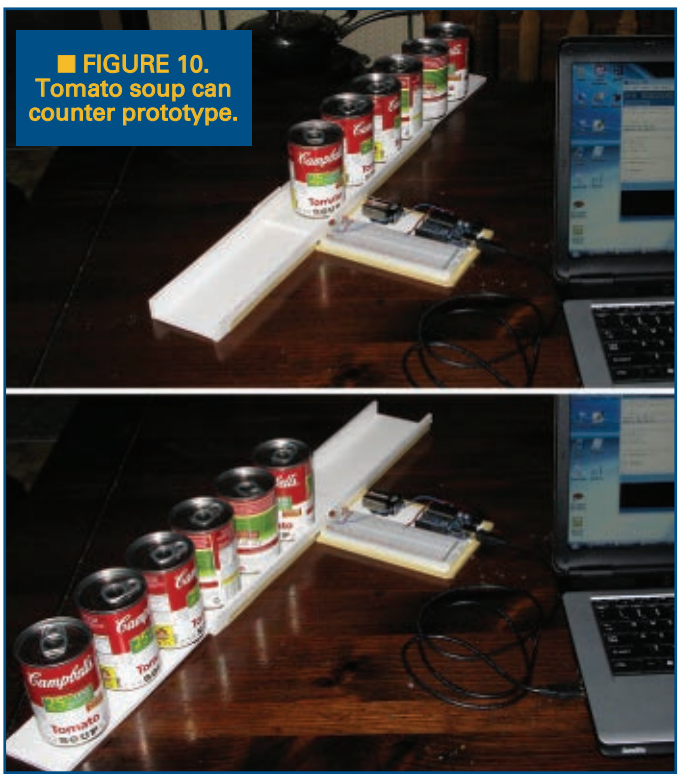
When I set up the soup can conveyer and slowly moved a can past the sensor while observing the results from the ReadPot TAW software on the Arduino Serial Monitor (slow since the code is only measuring once per second), I saw a range of values above (>600) which I could be certain that a can is present and another range below which I could be sure there was no can present (<300). There is also a sloppy mid range where I couldn't be sure (301 to 599). Remember your values won't be the same as mine. You must make your own measurements to determine the certain ranges: YES_CAN and NO_CAN, then use a true/false variable 'yes' to decide if a can has passed the sensor. There really are many ways to do this kind of thing, but I selected the easy (for me) to understand logic of:

If the analogInput is greater than YES_CAN **and** yes is equal to 0, **then** set yes to 1. **Else if** analogInput is less than NO_CAN **and** yes is equal to 1, **then** set yes equal to 0 and increment the can count.

■ FIGURE 11. ADC readings of finger movements.



Think about this for a moment from the perspective of a can moving by the sensor. Before the can gets there, 'yes' is equal to 0 for false and the analogInput value is less than the YES_CAN constant we have predetermined that indicates a can is present. As the can moves into view of the sensor, at some point analogValue becomes greater than YES_CAN so we know there is a can and we set 'yes' equal to 1 for true (yup, there is definitely a can present). Then, we keep measuring as the can slides past and the analogInput drops to a value less than NO_CAN. We check and see that 'yes' is true, so there was a can, but now our analogInput reading says there is no can, so it must have passed by. We set 'yes' to 0 and increment the can count. Whew! This will probably



■ FIGURE 10. Tomato soup can counter prototype.

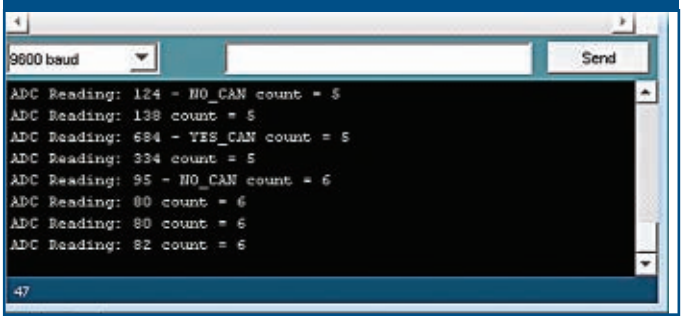
You can find the source code and supplements for this article in Workshop15.zip at www.nutsvolts.com.

be clearer from reading the source code.

I put YES_CAN and NO_CAN in the Tomato_Soup _Can_Counter source code as hard-coded constants (this is not a good programming practice, but it is useful here for keeping things simple).

```
// Tomato_Soup_Can_Counter
// Joe Pardue June 27, 2009

// Sensor level constants
#define NO_CAN 300
#define YES_CAN 600

// 0 if NO_CAN, 1 if YES_CAN
int yes = 0;
// Can count
int count = 0;

// variable for analog input value
int analogValue = 0;

void setup()
{
  // begin the serial communication
  Serial.begin(9600);
}

void loop()
{
  // read the analog input on pin 0
  analogValue = analogRead(0);

  // print prolog to value
  Serial.print("ADC Reading: ");
  Serial.print(analogValue, DEC);

  // If the analogInput is greater than YES_CAN
  //  and yes is equal 0 set yes to 1.
  // If analogInput is less than NO_CAN
  //  and yes is equal 1, set yes equal 0
  //  and increment count.
  if ((analogValue > YES_CAN) & (yes == 0)){
    yes = 1;
    Serial.print(" - YES_CAN");
  }
  else if ((analogValue < NO_CAN) & (yes == 1)){
    yes = 0;
    Serial.print(" - NO_CAN");
    count++;
  }

  // show the count
  Serial.print(" count = ");
  Serial.print(count, DEC);

  // print a newline
  Serial.println();

  // delay 1 second before the next reading:
  delay(1000);
  }
```

■ FIGURE 12. Can count on Arduino serial monitor.



For this demonstration, I kept the time between ADC readings at one second to avoid being overwhelmed with serial data. When I first tried counting the cans, I got some weird can counts and found that I had to make my conveyer belt narrower so that the cans were all pretty close to the sensor when they passed. The serial output is shown in **Figure 12**.

Once you get the system calibrated, you should be able to remove the serial output and the one second delay, and set a flag so that you only output the count when it changes.

Please note that you should leave the detector circuit in place on the breadboard for next month's article. **NV**

The Arduino Projects Kit

Smiley Micros and *Nuts & Volts* are selling a special kit: The Arduino Projects Kit. Beginning with Workshop 9, we started learning simple ways to use these components, and in later Workshops we will use them to drill down into the deeper concepts of C programming, AVR microcontroller architecture, and embedded systems principles.

With the components in this kit you can:
- Blink eight LEDs (Cylon Eyes)
- Read a pushbutton and eight-bit DIP switch
- Sense voltage, light, and temperature
- Make music on a piezo element
- Detect objects, edges and gray levels
- Optically isolate voltages
- Fade LED with PWM
- Control motor speed

And more ...

A final note: The USB serial port on the Arduino uses the FTDI FT232R chip that was discussed in detail in the article "The Serial Port is Dead, Long Live the Serial Port' by yours truly in the June 2008 issue of *Nuts & Volts*. You can also get the book "Virtual Serial Programming Cookbook" (also by yours truly) and associated projects kit from either *Nuts & Volts* or Smiley Micros.

FRONT PANELS & ENCLOSURES

Customized front panels can be easily designed with our free software Front Panel Designer

- Cost-effective prototypes and production runs
- Wide range of materials or customization of provided material
- Automatic price calculation
- Fabrication in 1, 3 or 7 days

Sample price:
$43.78 plus S&H

FRONT PANEL EXPRESS

www.frontpanelexpress.com
(206) 768-0602

Extreme Robot Speed Control!

Sidewinder

$399

- 14V - 50V - Dual **80A** H-bridges - 150*A+ Peak!*
- Adjustable current limiting
- Temperature limiting
- Three R/C inputs - serial option
- Many mixing options - Flipped Bot Input
- Rugged extruded Aluminum case
- 4.25" x 3.23" x 1.1"

RC Control

$39.99

Scorpion Mini
- **2.5A** (6A pk) H-bridge
- 5V - 20V
- 1.6" x .625" x 0.25"

$159.99

BotsIQ Favorite!

$104.99
2+ price

Scorpion XXL
- Dual **20A** H-bridge *45A Peak!*
- 5V - 28V
- 2.7" x 1.6" x 0.75"

Scorpion XL
- Dual **13A** H-bridge
- 5V - 28V
- 2.7" x 1.6" x 0.5"

Dalf Motion Control System
- Closed-loop control of two motors
- Full PID position/velocity loop
- Trapezoidal path generator
- **Windows GUI for all features**
- Giant Servo Mode!
- C source for routines provided
- PIC18F6722 CPU

$250

See *www.embeddedelectronics.net*

NEW!!

Magnum775
- planetary gearbox
- 20:1 ratio - 700 rpm
- RS-775 motor
- Nearly 700W!
- Build something - rule BotsIQ!

$89

H-bridges: Use with Dalf or Stamp

$79

Simple-H
- 6-28V **25A!**
- 2.25"x2.5"x0.5"
- 3 wire interface
- current & temp protection

ROBOT POWER™

MADE IN THE USA

We also do consulting!
Give us a call for a custom motor control to meet your exact needs

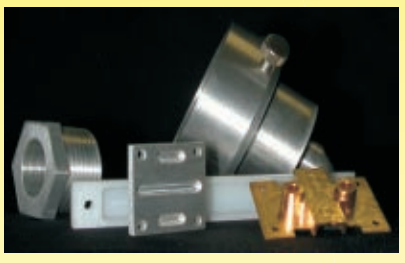
www.robotpower.com
Phone: 253-843-2504 • sales@robotpower.com

Complete Fabrication Center

AS 9100 Registration In Process

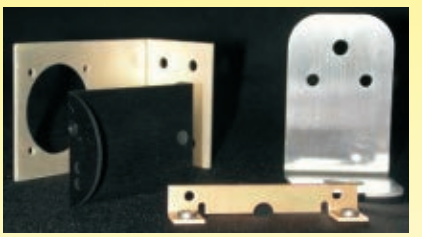
Quality prototype parts within 24 hours!!

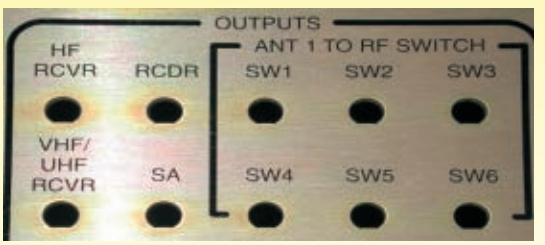
Precision Laser, Waterjet, Plasma, Machining, Micro-Machining, Forming, and Welding Capabilities



Parts from practically any material and from 0.001" to 6.000" in thickness.

Finishes such as powder coat, paint, plating, anodizing, silk screen, and more!





Fabricated, silkscreened and shipped in 2 business days with no expedite charges!

* Quick
* Affordable
* Precise
* No Minimums

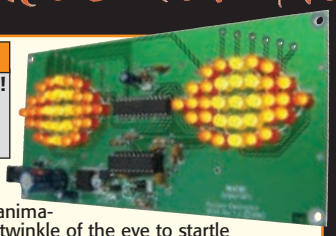
24 hour turn time based on quantity and finish requirements

Integrated Ideas & Technologies, Inc.
6164 W. Seltice Way • Post Falls, ID • 83854 • USA
Ph (208) 262-7200 • Fax (208) 262-7177 •
www.iitmetalfab.com

RAMSEY
Spooktacular Halloween Treats!

Blinky-Eyes Animated Display

- ✔ **Animated display of 66 super bright LED's!**
- ✔ **Microcontroller controlled!**
- ✔ **Changes brightness automatically!**
- ✔ **Animated with constant motion!**



The ultimate animated LED kit that will dazzle you and delight your friends! Uses a microcontroller to randomly select from many different animations such as a long pause before a wink, or a twinkle of the eye to startle passers-by!

Four modes to satisfy any enthusiast's desires: 1. Off for long random periods, then blinks or winks. Designed to scare! 2. On for long periods before performing an animation, perfect for costumes and displays! 3. Animates all the time for constant motion, perfect display attention-getter. 4. Random fire! When placed in a pumpkin will light it up like you wouldn't believe! As if this weren't enough, the BE66 can also control a small hobby motor to shake bushes at random intervals or signal an external player to make a scary sound! Also has a CDS cell to sense light. In one mode, the display will dim as it gets dark for battery operation, and in the other it will turn off when it's too bright, so it plays only in the dark!

BE66 **Blinky-Eyes Animated Display Kit** **$59.95**

Laser Light Show

- ✔ **Audio input modulates pattern!**
- ✔ **Adjustable pattern & size!**
- ✔ **Projects neat motorized patterns!**
- ✔ **Uses safe plastic mirrors!**

You've probably seen a laser show at concerts or on TV. They're pretty impressive to say the least! Knowing that you can't afford a professional laser display we challenged our engineers to design one that's neat and easy to build, yet inexpensive.

Well, the result is the LLS1 Laser Light Show! This thing is sweet and perfect for your haunted house or halloween parties! It utilizes two small motors and a small standard laser pointer as the basics. Then, we gave it variable pattern and speed controls to customize the pattern!

Not enough, you say? How about a line level audio input to modulate the pattern with your CD's, music, or spooky sound effects? You bet! Everything is included, even the small laser pointer. Runs on 6-12 VDC or our standard AC adapter.

LLS1 **Laser Light Show Kit** **$49.95**
AC125 **110VAC Power Supply** **$9.95**

Tri-Field Meter & *"Ghost Detector"*

- ✔ **See electric, magnetic, and RF fields!**
- ✔ **Watch the magnetic fields of the earth!**
- ✔ **Sense different magnetic poles**
- ✔ **Detect RF transmitter fields**
- ✔ **Graphical LED display allows you to "see"the invisible fields**
- ✔ **Great learning tool for EMF, RF, and manetic field theory.**

As Seen On CBS's Ghost Whisperer

Call it a Tri-Field Meter, an Electrical, Magnetic, and RF Detector, a Ghost Detector, or a Tricorder, but walking around with this on Halloween will seriously impress even the most doubting!

The TFM3C has three separate field sensors that are user selectable to provide a really cool readout on two highly graphical LED bargraphs! Utilizing the latest technology, including Hall Effect sensors, you can walk around your house and actually "SEE" these fields around you! You will be amazed at what you see. How sensitive is it? Well, you can see the magnetic field of the earth... THAT'S sensitive!

The technical applications are endless. Use it to detect radiation from monitors and TV's, electrical discharges from appliances, RF emissions from unknown or hidden transmitters and RF sources, and a whole lot more! If you're wondering whether your wireless project or even your cell phone is working, you can easily check for RF! A 3-position switch in the center allows you to select electric, magnetic, or RF fields. A front panel "zero adjust" allows you to set the sensors and displays to a known clean "starting point."

If the TFM3C looks familiar, it's probably because you saw it in use on the CBS show Ghost Whisperer! It was used throughout one episode (#78, 02-27-2009) to detect the presence of ghosts!

The concept is simple, it is believed (by the believers!) that ghosts give off an electric field that can be detected with the appropriate equipment. In the electric mode, the TFM3C's displays will wander away from zero even though there isn't a clear reason for it (not scientifically explainable, aka paranormal!). This would mean something has begun to give off an electric field. What it was in the Ghost Whisperer was a friendly ghost. What it will be in your house... who knows! Makes a GREAT leaning project besides! Requires 4 AA batteries.

TFM3C **Tri-Field Meter Kit With Case** **$74.95**

Automatic Animated Ghost

- ✔ **Automatically greets your visitors!**
- ✔ **Responds to sudden noises!**
- ✔ **Built-in microphone!**
- ✔ **Adjustable sensitivity**

Who says ghosts are make believe? Once your friends come upon this one they'll think differently! The unique circuit board design includes two ominous blinking eyes that change with various conditions, including sudden changes in ambient noise. A highly sensitive built-in microphone picks up anything from noises to talking and makes the ghost dance with its built-in motor, make eerie sounds with the built-in speaker, and randomly blink. A white cloth and a hanger are included as shown to make it look like the real thing. Runs on 2 AAA batteries (Not included).

MK166 **Automatic Animated Ghost Kit** **$21.95**

Halloween Pumpkin

- ✔ **25 bright LED's!**
- ✔ **Random flash simulates flickering candle!**
- ✔ **Super bright LED illuminates entire pumpkin!**
- ✔ **Simple & safe 9V battery operation**

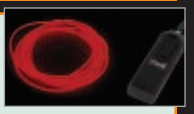
The perfect "starter" kit with a terrific Halloween theme! You won't be scraping the seeds and guts out of this pumpkin! Six transistor circuit provides a neat random flash pattern that looks just like a flickering candle. Then a super bright LED illuminates the entire pumpkin with a spooky glow!

The pumpkin face is the actual PC board, and assembly is easy through-hole soldering of all components and LED's. Your pumpkin is powered by a standard 9V battery (not included) which snaps to the back of the pumpkin. An on/off switch is also included. Create a new kind of pumpkin this year, and learn about LED's and electronics at the same time!

MK145 **Electronic Halloween Pumpkin Kit** **$10.95**

Portable EL Electroluminescence

- ✔ **3.3 feet long!**
- ✔ **Low power consumption!**
- ✔ **Highly visible brilliant colors**



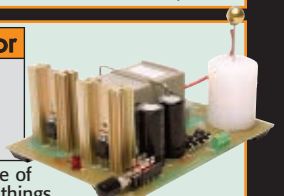
Electroluminescence illuminated flexible wire sets can be used for a lot of things but when they're battery powered they're perfect for Halloween and Trick or Treat safety concerns! Each thin, flexible EL wire set is 3.3' long and runs on two standard AA batteries (not included). Current consumption is less than 100mA for long life.

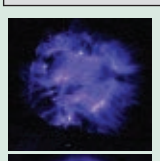
Mode settings include steady glow and slow or fast flash! Make it part of a brilliantly lit, custom designed costume or simply add it for illuminated safety while Trick or Treating in the dark.

NWRR15 **EL Illumination Wire Set, Red** **$19.95**
NWRG15 **EL Illumination Wire Set, Green** **$19.95**
NWRB15 **EL Illumination Wire Set, Blue** **$19.95**

Spark Generating HV Plasma Generator

- ✔ **Generate 2" sparks to a handheld screwdriver!**
- ✔ **Light fluorescent tubes without wires!**
- ✔ **Build your own Plasma Balls!**
- ✔ **Generates up to 25kV @ 20 kHz from a solid state circuit!**





This popular kit was conceived by one of our engineers who likes to play with things that can generate large, loud sparks, and other frightening devices! And at Halloween there's no better effect than high voltage sparks flying through the air! The PG13 Plasma Generator creates a very impressive 25,000 volts at 20 kHz, to provide a stunning display of high voltage! It will draw a cool looking 2" spark to hand held screwdriver, or light fluorescent tubes without any connection!

It produces stunning lighting displays, drawing big sparks, to perform lots of high voltage experiments. In the picture, we took a regular clear "Decora" style light bulb and connected it to the PG13 - WOW! A storm of sparks, light tracers and plasma filled the bulb. Holding your hand on the bulb doesn't hurt a bit and you can control the discharge! It can also be used for powering other experiments; let your imagination be your guide! Operates on 16VAC/VDC for maximum output. Can also be run from 5-16VAC/VDC to reduce the output voltage.

PG13 **Plasma Generator Kit** **$64.95**
PS21 **110VAC Input, 16VAC Output, Power Supply** **$19.95**

OBDII *CarChip Pro*

The incredible OBDII plug-in monitor that has everyone talking! Once plugged into your vehicle it monitors up to 300 hours of trip data, from speed, braking, acceleration, RPM and a whole lot more. Reads and resets your check engine light, and more!

8226 CarChip Pro OBDII Monitor $99.95

Practice Guitar Amp & DI

Practice your guitar without driving your family or neighbors nuts! Works with any electric, acoustic-electric, or bass guitar. Plug your MP3 player into the aux input and practice to your favorite music! Drives standard headphones and also works as a great DI!

PGA1 Personal Practice Guitar Amp Kit $64.95

Passive Aircraft Monitor

The hit of the decade! Our patented receiver hears the entire aircraft band without any tuning! Passive design has no LO, therefore can be used on board aircraft! Perfect for airshows, hears the active traffic as it happens! Available kit or factory assembled.

ABM1 Passive Aircraft Rcvr Kit $89.95

LED Blinky

Our #1 Mini-Kit for over 35 years! Alternately flashes two jumbo red LED's. Great for signs, name badges, model railroading, and more. Used throughout the world as the first learning kit for students young and old! Great solder practice kit. Runs on 3-15 VDC.

BL1 LED Blinky Kit $7.95

LED SMT Blinky

The subminiature high-tech version of the BL1! Utilizes all SMT components to drive a pair of high intensity SMT LED's. Runs on 2 button cells (included). Great attention grabber for signs, hats, or other applications.

BL2 LED SMT Blinky Kit $17.95

Electronic Siren

Exactly duplicates the upward and downward wail of a police siren. Switch closure produces upward wail, releasing it makes it return downward. Produces a loud 5W output, and will drive any speaker! Horn speakers sound the best! Runs on 6-12VDC.

SM3 Electronic Siren Kit $7.95

Universal Timer

Build a time delay, keep something on for a preset time, provide clock pulses or provide an audio tone, all using the versatile 555 timer chip! Comes with circuit theory and a lots of application ideas and schematics to help you learn the 555 timer. 5-15VDC.

UT5 Universal Timer Kit $9.95

Voice Activated Switch

Voice activated (VOX) provides a switched output when it hears a sound. Great for a hands free PTT switch or to turn on a recorder or light! Directly switches relays or low voltage loads up to 100mA. Runs on 6-12 VDC.

VS1 Voice Switch Kit $9.95

Tone Encoder/Decoder

Encodes OR decodes any tone 40 Hz to 5KHz! Add a small cap and it will go as low as 10 Hz! Tunable with a precision 20 turn pot. Great for sub-audible "CTS" tone squelch encoders or decoders. Drives any low voltage load up to 100mA. Runs on 5-12 VDC.

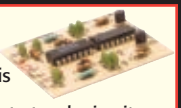
TD1 Encoder/Decoder Kit $9.95

20 Watt Mini Audio Amp

Delivers a super clean 20W output from one SMT package! Ultra efficient class D design produces no heat. PCB can be snapped into a small circle for special applications. Runs on 18VDC for rated output, or down to 10VDC for reduced output.

UAM2 20W Subminiature Amp Kit $34.95

Touch Switch



Touch on, touch off, or momentary touch hold, it's your choice with this little kit! Uses CMOS technology. Actually includes TWO totally separate touch circuits on the board! Drives any low voltage load up to 100mA. Runs on 6-12 VDC.

TS1 Touch Switch Kit $9.95

Walking Electronic Bug

Built around a pair of subminiature cell phone motors, this bug wanders around looking for things to bump into! Sensors below his LED eyes sense proximity and make him turn away! Steer him with flashlights too! Runs on two "N" batteries.

WEB1 Walking Bug Kit $29.95

Mad Blaster Warble Alarm

If you need to simply get attention, the "Mad Blaster" is the answer, producing a LOUD ear shattering raucous racket! Super for car and home alarms as well. Drives any speaker. Runs on 9-12VDC.

MB1 Mad Blaster Warble Alarm Kit $9.95

Xenon Tube Strobe Light

Create amazing effects with an authentic Xenon tube strobe light! Creates a super bright white FLASH with a variable speed of 2 to 20 flashes second. Just connect 110VAC and and you have a complete strobe light!

K5300 Xenon Tube Strobe Light Kit $19.95

Stereo Ear Super Amplifier

Ultra high gain amp boosts audio 50 times and it does it in stereo with its dual directional stereo microphones! Just plug in your standard earphone or headset and point towards the source. Incredible gain and perfect stereo separation!

MK136 Stereo Ear Amp Kit $9.95

Water Sensor Alarm

This little $8 kit can really "bail you out"! Simply mount the alarm where you want to detect water level problems (sump pump!). When the water touches the contacts the alarm goes off! Sensor can even be remotely located. Runs on a standard 9V battery.

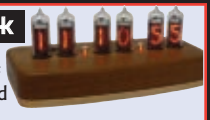
MK108 Water Sensor Alarm Kit $6.95

Air Blasting Ion Generator

Generates negative ions along with a hefty blast of fresh air, all without any noise! The steady state DC voltage generates 7.5kV DC negative at 400uA, and that's LOTS of ions! Includes 7 wind tubes for max air! Runs on 12-15VDC.

IG7 Ion Generator Kit $64.95

Retro Nixie Tube Clock



Genuine Nixie tubes popular in the 50's brought back in one of the neatest digital clocks around today! Hand made teak maple base, 12/24 hour format, soft fade-out, auto-dim, and a crystal time base at 20ppm! Tube kits also available.

IN14TM HV Plasma Generator Kit $329.95

SMT Soldering Lab

Learn all about SMT parts and how to solder them! Surface mount parts are tiny and require a special skill to solder. This lab and course covers it all, and you end up with a great "Decision Maker" kit when done!

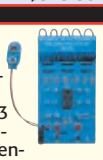
SM200K SMT Soldering Lab Kit $22.95

Soldering Lab

The perfect beginner's project specifically designed to teach you the fundamentals of soldering and PC boards. You will not only learn soldering, but hoto troubleshoot soldering problems and how to fix them! Final project runs on 9V battery.

SP1A Soldering Lab Kit $9.95

Soldering Parts Lab



Not only will you learn soldering and desoldering but you will also learn component identification and color codes! Includes 163 solder points, and you will learn how to solder all types of components. The comprehensive manual even includes exams!

SP3B Soldering Parts Lab Kit $9.95

IC AM/FM Radio Lab

Learn all about AM/FM radio theory, IC theory, and end up with a high quality radio! Extensive step-by-step instructions guide you through theory, parts descriptions, and the hows and whys of IC design. Runs on a standard 9V battery.

AMFM108K AM/FM IC Radio Lab Kit $34.95

Non-Conductive Tweezers

We've discussed tweezers and magnifiers while working with SMT components. Working with highly sensitive components, ESD safe tweezers can be a life saver! This set of 4 non-conductive tweezers are perfect for any static sensitive devices, and are priced right!

VTTWSET2 Non-Conductive Tweezers Set $3.95

3-In-1 Multifunction Lab

The handiest item for your bench! Includes a RoHS compliant temp controlled soldering station, digital multimeter, and a regulated lab power supply! All in one small unit for your bench! It can't be beat!

LAB1U 3-In1 Multifunction Solder Lab $129.95

Get The Catalog!

Get the 2009 Ramsey Hobby Catalog! ***96 value packed pages*** of the neatest goodies around with lots of new stuff! Order yours today on line or give us a call... Or download the PDF at www.ramseykits.com/catalog!

www.ramseykits.com

800-446-2295

Where Electronics Is Always Fun!

✦ ***Build It!*** ✦ ***Achieve It!***
✦ ***Learn It!*** ✦ ***Enjoy It!***

ramsey
www.ramseykits.com
590 Fishers Station Drive
Victor, NY 14564
(800) 446-2295
(585) 924-4560

Prices, availability, and specifications are subject to change. Not responsible for typos, stupids, printer's bleed, or really weird Halloween tricks! Visit www.ramseykits.com for the latest pricing, specials, terms and conditions. Thanks Robin... for reminding me of this ad deadline and that Halloween is approaching! Therefore today's color theme is Pantone 021C Orange! Copyright 2009 Ramsey Electronics, LLC...so there!

Q&A

WHAT'S UP:

Join us as we delve into the basics of electronics as applied to every day problems, like:

- ✓ PICAXE or PIC?
- ✓ Game Show Lockout
- ✓ Fluorescent Ballast

■ WITH RUSSELL KINCAID

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, comments, or suggestions.

Send all questions and comments to:
Q&A@nutsvolts.com

GAME SHOW LOCKOUT

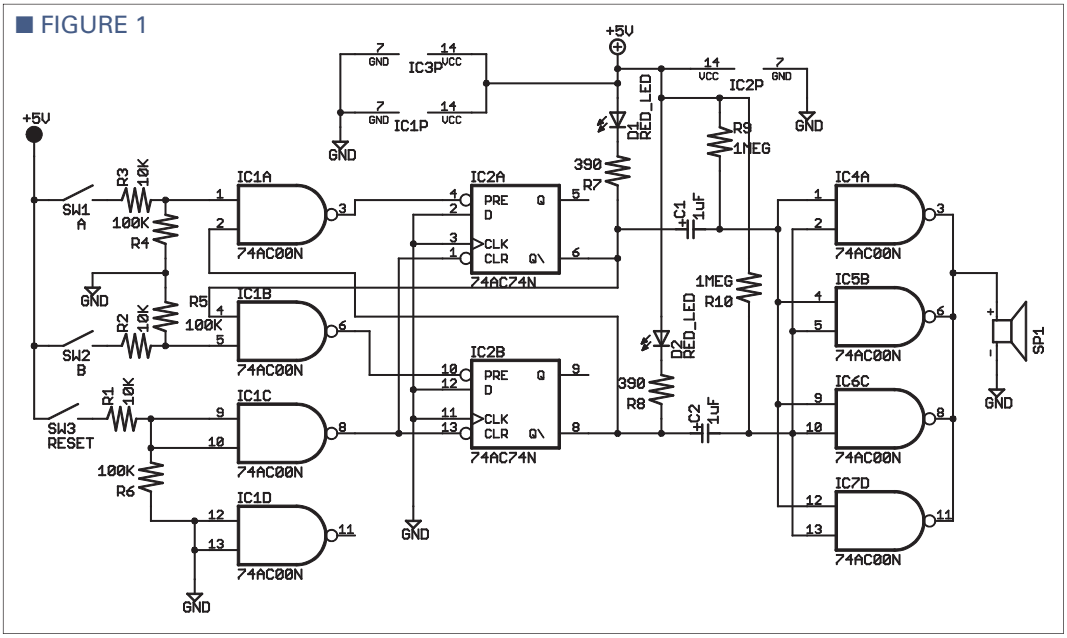
Q I saw a comment in a forum about a game show lock-out and was wondering if you had a schematic or description of the circuit I could use. I only need a two person buzzer system.

— Michael Hickmon

A I answered a similar question in my very first column, May 2007, page 29, but that was more complex than what you need. This solution is adapted from a Pinewood Derby design I did many years ago. In **Figure 1**, the flip-flops are initially reset by the game master so the NOT-Q outputs are high. When contestant A or B presses his switch, the Q output goes high and the NOT_Q output goes low, lighting the LED and sounding the buzzer. I thought it would be annoying for the buzzer to be sounding until reset, so I put in an R-C which will allow the buzzer to sound for about one second, until the capacitor charges up. IC4 is an inverted OR gate; when any input goes low, the output goes high. I used 74AC logic because it has high output current capability and paralleled the outputs of IC4 for up to 100 mA drive.

The parts list is **Figure 2**; those are all Mouser part numbers.

■ FIGURE 1



MICROCONTROLLERS

Q I wish to step up from the 555s, etc., to micro-controllers for projects as found in Smiley's Workshop, PICAXE Primer, Getting Started with PICs, and others found in *N & V*. My questions are: **1.** Would you share your pros and cons on microcontrollers by AVR vs. PICAXE vs. Microchip's PIC line? **2.** What devices do I need to program with a computer? **3.** What devices do I need to program without a computer? **4.** Now that I have the car, where can I get driving instructions?

I am leaning toward the PIC line because of availability and price.

— Weldon Thorp

A I will answer your questions in reverse: **4.** Not knowing where you are, I can't answer that. **3.** I don't want to think about how you would program without a computer. **2.** You could program in assembly code which is converted to hex code that the micro understands or, more likely, you would program in a higher level language such as C or

Basic which is converted into assembly code which, in turn, is converted into hex code. In any case, you will need a cable to connect the computer to the micro, and a suitable platform for the micro. **1**. I am a novice when it comes to microcontrollers and know nothing about AVR. I have looked into PICAXE and I have worked with PICs. It is my observation that PICAXE is aimed toward the novice and some flexibility is sacrificed for simplicity. PICAXE uses the Microchip devices and loads a bootstrap program that allows the novice to download the program to the chip without a "programmer." The big advantage of the PICAXE system is that the Basic software is free. Microchip has a free version of its software with limited lines of code but the pro version is expensive.

If you start with PICAXE, you will soon want to upgrade to PICs, so I think you will be wise to start with PICs.

MICROPROCESSORS

Q A microprocessor is completely foreign territory to me. I appreciate the simplicity and low parts count of your circuits, but what do you need in order to get the program you supplied into the PIC? In looking up the part and its datasheet, I find reference to a compiler and perhaps other equipment. While the chip itself is in the order of $1.20, the referenced compiler looks to run in the order of $100+. Assuming I have nothing other than a computer on hand to begin with — which I don't — can you give me a list of what I would have to get in addition to the PIC in order to make it work? About how much might it all cost and could it be used with any subsequent microprocessor, or do you need to get new equipment for each different microprocessor?

I have shied away from micros for many years but would like to get my feet wet now. Any help you can offer would be greatly appreciated.

— Clark Kuhl

A Microchip does have a free version of their software, but it has limited application and program size. I initially used a programmer from **www.elproducts.com** which cost $24.95. I now use a different one with a zero force socket and USB interface which costs $129.90. The Basic software from Microchip is expensive but they have a free demo version with a limit of 31 lines of code. Crownhill also has a compiler which I evaluated and did not like the syntax. However, others may like it and there is a free version which supports many PIC devices; look for Proton Lite in **Figure 3**.

The PICAXE system may be best for "getting your feet wet" with micros. The cost is comparable to PIC programming with demo versions but you can write large programs with the free software. See the Mailbag for more on this system. Figure 3 is a catalog of available software and hardware that I know about.

RADIO DISTANCE MEASUREMENT

Q I would like to build a system for measuring distances from one to 50 meters. I envision two electronic units: A and B. Each unit contains a transmitter and receiver. Transmitter A sends a signal to receiver B. Receipt of the signal by B causes B to transmit a signal back to receiver A. Receipt of the signal by A causes A to transmit another signal to B. This relay process continues until inhibited by a microcontroller in unit A. At a distance of one meter, the time for radio wave transmission

14 VOLT REGULATOR PARTS LIST

■ FIGURE 2

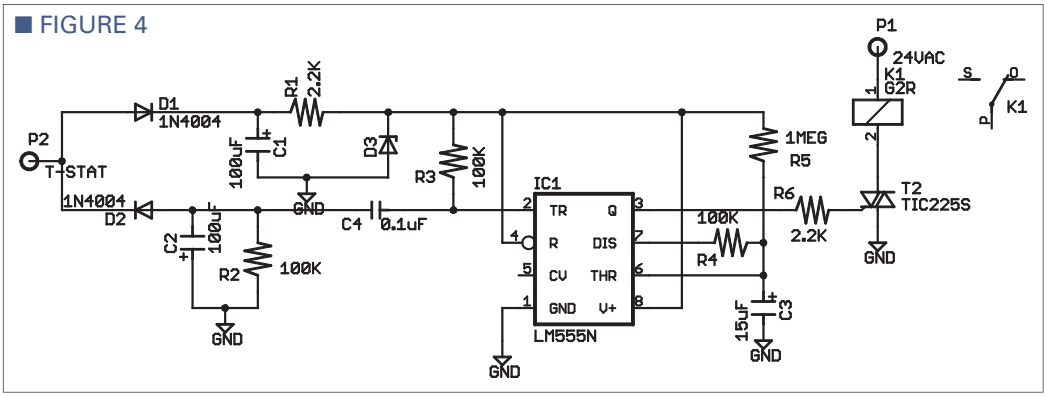
PART	DESCRIPTION	PART #	COST
SP1	FIVE VOLT BUZZER	665-AI-1622WT5VR	3.20
SW1, SW2, SW3	PUSHBUTTON, NO	107-3006-EVX	4.54
IC1, IC5	74AC00 QUAD NAND	595-SN74AC00N	0.40
IC2	74AC74 DUAL D-FF	595-SN74AC74N	0.40
D1, D2	RED LED, 8 MM	604-WP7931D	0.30
C1, C2	1 µF, 35V, TANTALUM	581-TAP105K035SCS	0.40
R1, R2, R3	10K, 1/4 W	291-10K-RC	0.40/10
R4, R5, R6	100K, 1/4 W	290-100K-RC	0.40/10
R7, R8	390 OHMS, 1/4 W	290-390-RC	0.40/10
R9, R10	ONE MEG, 1/4 W	290-1M-RC	0.40/10

AVAILABLE PIC PRODUCTS

■ FIGURE 3

WEBSITE	DESCRIPTION	COST
www.beginnerelectronics.com/beginner/Products.php	EZPIC PROGRAMMER KIT	$19.95
	SERIAL CABLE	$6.00
www.melabs.com/pbpdemo.htm	PICBASIC PRO COMPILER DEMO	FREE
www.melabs.com/products/pbc.htm	PICBASIC COMPILER	$99.95
www.melabs.com/products/usbprog.htm	U2 USB PROGRAMMER	$89.95
www.melabs.com/products/adapters/dipadpt.htm#Adapters	8 TO 40 PIN ZIF ADAPTER	$39.95
www.picbasic.org/proton_development_suite.php	PROTON DEVELOPMENT SUITE	$168.92
www.picbasic.org/proton_lite.php	PROTON LITE (includes compiler)	FREE
www.picbasic.org/proton_lite.php	PICAXE-20M STARTER PACK KIT WITH CABLE AND CD-ROM (includes shipping)	$23.64

■ FIGURE 4



TIMED RELAY PARTS LIST

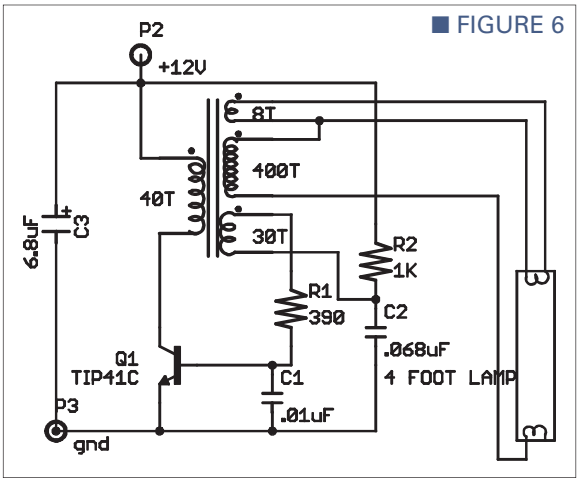
■ FIGURE 5

PART	DESCRIPTION	MOUSER PART #	COST
D1, D2	1 AMP RECTIFIER > 50V	512-1N4004	0.07
D3	12V ZENER, 1W	78-1N4742A	0.05
C1, C2	100 µf, 50V, ALUMINUM	140-XRL50V100-RC	0.11
C3	15 µF, 20V, TANTALUM	80-T495D156K035	1.41
C4	0.1 µF, 50V, 10%	80-C320C104K5R	0.15
IC1	555 TIMER	512-LM555CN	0.31
T2	TRIAC, 400V, 5A	576-L2006L5	1.16
K1	24 VAC RELAY	ANY LOCALLY AVAILABLE	
R1, R6	2.2K, 1/4W, 5%	660-MF1/4DC2211F	0.06
R2, R3, R4	100K, 1/4W, 5%	660-MF1/4DC1003F	0.06
R5	ONE MEG, 14W, 5%	660-MF1/4DC1004F	0.06

(one way) is about 3.3 nS. Fixed time delays within A or B may be needed to slow the process down to rates that do not require overly sophisticated circuits or PCB design. I expect to let the cycle run for 10,000 to 100,000 cycles in order to accumulate enough time (several microseconds) to measure the desired distances using a typical microcontroller timer/counter. Can you recommend a suitable transmitter and receiver circuit, as well as a signal format?

— Rodney Case

■ FIGURE 6



A The first problem I see is that the difference between one meter and two meters is 3.3 nS. You are not able to change that. If you add 20 nS to each receiver, the loop time for one meter is 36.6 nS; the loop time for two meters is 43.2 nS. The corresponding frequencies are 27.3 MHz and 23.15 MHz. You can easily purchase a counter for those frequencies and, with a lookup table, convert to distance. You would want about a 10 nS pulse at 3 or more GHz for the signal. Nanosecond pulses and GHz frequencies are out of my comfort zone, so I can't help you there. I am too much of a neophyte to attempt the counter/micro interface but it does not seem complicated for a knowledgeable person.

TIMED RELAY

Q I am trying to come up with a circuit where a 24 VAC NO relay — when energized by a 24 VAC thermostat — would stay closed for only 15-20 seconds and go back to normally open. Can you help?

— Ed WA2BIG

A **Figure 4** is my solution. The t-stat will send 24 VAC to the circuit when it is calling for heat (or cooling) which will charge the capacitor C1 to 34 volts DC. Capacitor C2 is charged to -34 VDC and this change in voltage is passed on to the trigger of IC1 through C4. As C4 charges, the trigger voltage rises so it will not re-trigger. The circuit is powered by the t-stat signal but it could just as well have been powered by the 24 VAC source. The time delay is about 16 seconds with C3 = 15 µF. The parts list is **Figure 5**.

I initially planned to send the t-stat signal to the gate of the triac with just capacitor coupling similar to the 555 trigger (except positive rectified), but I breadboarded it and found that the triac turns on easily for the positive alternations of AC but requires nearly 5 mA drive to turn on the negative alternation. Not knowing how the relay would react to half wave rectified current, I decided to use the 555 to give a clean 5 mA turn-on signal.

12 VOLT FLUORESCENT BALLAST

Q A while back, you mentioned that you preferred fluorescent to LEDs for high efficiency lighting. Could you design a small, lightweight, efficient, and inexpensive ballast circuit to power fluorescent lamps of different wattages? It would need to be able to work with input voltages of 12.5-14.5 VDC. Please use currently available parts; most examples of this sort of thing tend to use stuff from the designer's scrap box and are not available to the average guy.

— **Herbert Meister**

A My initial circuit was not working so I went online to see how others had done it. Most circuits use a blocking oscillator, so that is what I have designed. In **Figure 6**, Q1 is turned on by current through R1 and R2. The feedback through the transformer is positive, which turns Q1 on hard; the resulting base current drives C2 to a negative voltage. When the core approaches saturation, the secondary voltage is reduced which allows the negative voltage on C2 to turn Q1 off. Now the base of Q1 is driven negative to the zener point.

MAILBAG

Dear Russell:

Re: generator voltage regulator; July 2009 issue, page 35. There is an error with the generator voltage regulator circuit. It needs a diode between the output of the generator and the battery, or the battery will discharge into the generator when it is stopped. I did this on an old outboard boat motor which had a generator. If you look at the original regulator, it has a cutout relay to disconnect the generator from the battery when it is stopped.

— **Daniel Seraphinoff**

Response: You are absolutely right. My 1959 Lancia design had the diode but I couldn't find it, so I forgot. Mea culpa. I have corrected the schematic; see ***Figure A****.*

Dear Russell:

Re: July 2009 issue, page 32; Timer. What compiler did you use for the Figure 2 code?

— **Mike Seibel**

*Response: I use PICBASIC PRO compiler from microEngineering Labs (***www.melabs.com***) and Micro Code Studio which is a program editor and Windows interface that makes programming simpler. MicroCode Studio is bundled with PICBASIC PRO. There is a free version with limited lines of code.*

Dear Russell:

Re: July 2009 issue, page 32; Timer. I was reading the request from a reader named John S. Mitterer who was requesting some help with a circuit for his train set. Although I really liked the answer — and I learned from it — if John does not have the $200 PIC programmer, wouldn't a 555 timer (as an off delay) be the easiest and less costly option for the simple thing he is attempting to do?

I think that the reason you may have picked the PIC is the problem of seeing through the gap between cars, and part of the solution was to have two photo eyes. I would direct the beam at a 45 (or so) degree angle across the track so it would not see through the space between cars. Then the circuit becomes extremely simple and cheap to do. I would also probably use a 2N6426 to operate the relay coil. I think the cost of these two parts is less than $1. Anyway, this has peaked my interest in PIC chips. I have a BASIC Stamp 1 and also a BS2 (just for learning) but need to know more basics about the PIC chip for low cost control. Looking forward to that.

— **Mark Dietrich**

Response: Mr. Mitterer had the same complaint, so I designed a 555 circuit for him, which will appear in a future column. I did not think of your 45 degree solution; I wish I had because it is really best.

Dear Russell:

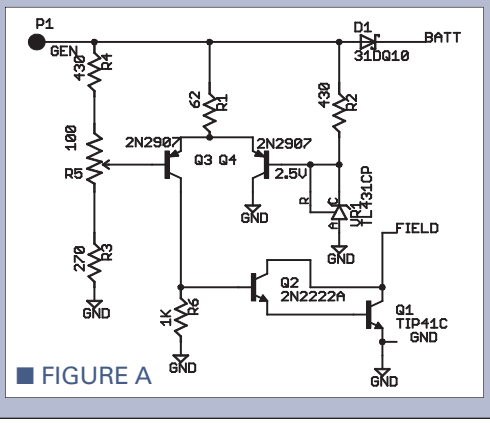
Re: July 2009 issue, page 32; Timer. In your answer to John S. Mitterer concerning a timer/train detection circuit, are you assuming that he has a PIC programmer? Not everyone does. Why not recommend a PICAXE-08M. No programmer is required – just a serial cable, two resistors, and the free-to-download Program Editor from **www.picaxe.co.uk**.

— **Al Hooper**

Response: A lot of people are beating me up on that, but I have a standing offer to supply a programmed PIC for $5 (postage included in the USA). Your suggestion of using the PICAXE is interesting; I checked into it and plan to use the PICAXE in a micro solution soon.

Dear Russell:

Re: July 2009 issue, page 34; Figure 6. You did not give a part number for the tri-color LED. I take it that you did not give values for the current limiting resistors because it would change with the LED device used.



■ FIGURE A

— **Ted Mieske**

Response: I was lazy and did not look up a part number for the tri-color LED. With 20-20 hindsight, I think the part would have four leads with a common anode and the resistors should have been on the cathode side.

Dear Russell:

Re: December 2009, page 24; 60 volt, 13 amp power supply. I tried to look up the Magnetics, Inc., core that you suggested (45021-EC) but could not find it in the Ferrite Cores catalog (2006 rev1). Their website search function could not find this core either. Is this a discontinued core or is the core number in error?

— **Ernie Moore**

Response: The correct part number is 42501-EC, I don't know how the numbers got mixed up, and perhaps my dyslexia is showing.

Dear Russell:

Just received my July issue of *NV*. Have a question on pages 32 to 33 (60 Hz generator) for W. Thorp; Figure 3. Can this circuit be changed to run at 400 Hz? Preferably 60 to 480 Hz. Also am thinking of changing Q2, Q3 to a LM675 power op-amp to drive a transformer backwards.

— **Craig Kendrick Sellen**

Response: To change the frequency, just change the resistors R1 and R2 by the ratio: 60/400. The circuit does not lend itself to tuning and if you want to have more power, just add it to the output. I am sure feedback around two op-amps would oscillate.

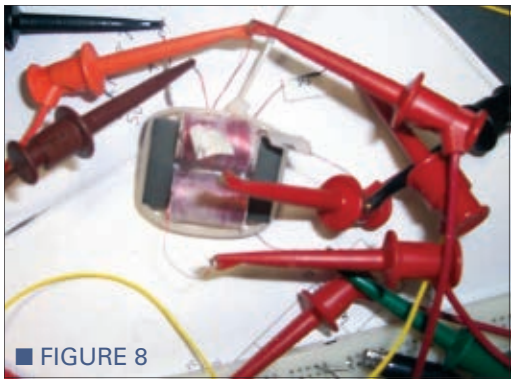
Dear Russell:

Re: Class D amplifier; June 2009, pages 31-32. There has been a thread on the *N&V* forum about your Class D Amp that needs your clarification.

— **Charles Ryberg**

Response: I understand the confusion; the design only does the positive alternation of the audio. It does not work; I don't know what I was thinking. Perhaps the design could be salvaged by repeating and paralleling the circuit with the output diodes reversed to give the negative alternation of audio — much like a class AB linear amp.

■ FIGURE 7



■ FIGURE 8

R1 limits the current to prevent damage to the transistor. The transistor remains cut off until the capacitors C1 and C2 charge up enough to turn Q1 on again and start the cycle over. The eight turn winding heats the filament which allows the tube to light at a lower voltage. The layout is not critical; I used a plug-in breadboard to test the circuit. The tube is not as bright as normal and the circuit draw is 1/2 amp at 12 volts.

The ferrite core is RadioShack part no. 273-104; it comes with a snap-together case (not used). You will want to make a pair of bobbins for the windings. I put the 40 turn primary, and the 30 and eight turn secondaries on one bobbin and the 400 turn secondary on the other bobbin. I used #26 wire for the primary and secondaries on one bobbin and #30 wire for the 400 turn secondary. Use Scotch tape to hold the wires in place. Make the bobbin out of heavy paper; a business card works well. I used a 3/8 and 1/2 inch punch to make end pieces. **Figure 7** is the bobbin and **Figure 8** is the finished transformer. Note the nylon tie holding everything together. I put a piece of business card between the two halves of the core to make an air gap, so the core does not saturate too soon. I used a TIP41C transistor but RadioShack has TIP3055 (276-2020) which should work. Other parts are available from RadioShack:

278-1345	Three spool wire set; includes #26 and #30
272-1019	Use for C3
272-1051	Use for C1
272-1069	Connect them in series for C2
271-1113	330 ohm, 1/2W for R1
271-1118	1K, 1/2W for R2

The entire circuit and wires should be in a metal container to minimize RF interference. Use the metal box as a heatsink for Q1; it will need it. **NV**

Full Speed

It writes your USB Code!

NEW! **HIDmaker FS for Full Speed FLASH PIC18F4550**

Creates complete PC and Peripheral programs that talk to each other over USB. Ready to compile and run!

- *Large data Reports*
- *64,000 bytes/sec per Interface*
- *Easily creates devices with multiple Interfaces, even multiple Identities!*
- *Automatically does MULTITASKING*
- *Makes standard or special USB HID devices*

NEW! "Developers Guide for USB HID Peripherals" shows you how to make devices for special requirements.

Both PC and Peripheral programs *understand your data items* (even odd sized ones), and give you convenient variables to handle them.

PIC18F Compilers: PICBASIC Pro, MPASM, C18, Hi-Tech C.

PIC16C Compilers: PICBASIC Pro, MPASM, Hi-Tech C, CCS C.

PC Compilers: Delphi, C++ Builder, Visual Basic 6.

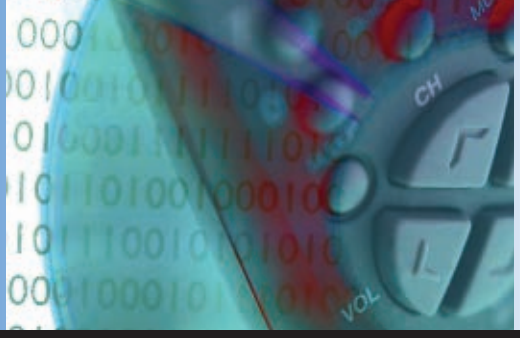
HIDmaker FS Combo: Only $599.95

Trace SYSTEMS, Inc.

DOWNLOAD the HIDmaker FS Test Drive today!

www.TraceSystemsInc.com

301-262-0300



NEW PRODUCTS

- HARDWARE
- SOFTWARE
- GADGETS
- TOOLS

GADGET PC
ULTRA-LOW POWER COMPUTER

GadgetPC is a tiny, ultra low power, high performance computer system based on the latest generation of ATMEL ARM9 micro-controllers now available from BiPOM Electronics. Taking advantage of low cost, off-the-shelf USB gadgets such as webcams, USB drives, network cards, Aircards, Zigbee, Bluetooth, USB hard drives, and others, GadgetPC opens the path to the next generation of computing and embedded applications — especially mobile robotics applications — that would normally be difficult to implement with power-hungry, bulky, expensive PC systems. GadgetPC has an open architecture with standard software components. It can run high-level operating systems such as Linux. Power consumption of the base board is well under 1 watt, eliminating the need for heatsinks and fans that are normally found on PC motherboards.

GadgetPC comes with pre-installed Linux and runs many standard applications such as the Web Server, FTP Server, Telnet Server, OpenSSH, Firewall, Router, Network Time Server, Email, Fax Server, and others. GadgetPC provides a PC replacement for light-weight server applications and embedded systems.

GadgetPC is fully backed by warranty, technical support, and application assistance from BiPOM Electronics.

For more information, contact:
BiPOM Electronics
Tel: **713-283-9970**
Email: **info@bipom.com**
Web: **www.bipom.com**

MIXED SIGNAL OSCILLOSCOPES

LeCroy Corporation has announced a new line of mixed signal oscilloscopes; the MSO Xs-A series. The new MSO offers four analog plus 18 digital channels with 10 Mpts/ch memory on all 22 channels simultaneously. The MSO Xs-A is available in 400 MHz, 600 MHz, and 1 GHz analog bandwidth with a maximum digital input frequency of 250 MHz. The processing power of the MSO Xs-A enables math, measurement, and serial data decoding on long

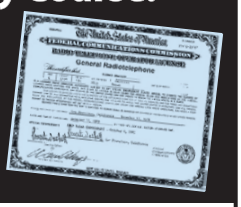
EARN MORE MONEY!

Be an FCC Licensed Wireless Technician!

Make $100,000 a year with NO college degree

Get your "FCC Commercial Radiotelephone License" with our proven Home-Study Course!

- No need to quit your job or go to school.
- This course is easy, fast and low cost.
- No previous experience needed!
- Learn at home in your spare time!



Move to the front of the employment line in Radio-TV, Communications, Avionics, Radar, Maritime and more… even start your own business!

Call now for FREE info:
1-800-932-4268 ext. 209

Or, email us:
fcc@CommandProductions.com

Send to: **COMMAND PRODUCTIONS**
Warren Weagant's FCC License Training
P.O. BOX 3000, DEPT. 209 • SAUSALITO, CA 94966
Please rush FREE info kit today!
NAME: _____
ADDRESS: _____
CITY/STATE/ZIP: _____
You may fax your request to: 415-332-1901

capture times. In addition, the MSO Xs-A includes advanced triggering capabilities which easily isolate and trigger on runts, glitches, or changes in slew rate. The Qualified AB event trigger permits arming the trigger on a specific event and triggering on a following event. The touch screen interface — unique in this class of instrument — is easy to use and simplifies setting up digital channel groupings and pattern triggers, eliminating the pushbuttons and scroll knobs required by other MSOs. Features such as WaveStream Fast Viewing Mode, WaveScan Search and Find, and serial data trigger and decode capabilities all combine to make the MSO Xs-A a powerful, flexible mixed signal oscilloscope.

For more information, contact:
LeCroy Corporation
Tel: **800-5LeCroy**
Web: **www.lecroy.com**

A COST EFFECTIVE SOLUTION FOR EMBEDDED COLOR VGA VIDEO

Multilabs announces the release of the ezVGA-LV Graphics Controller. The ezVGA-LV is an embedded color VGA processor that can be used to generate VGA signals for image display on VGA monitors and VGA compatible devices. Using the data instructions, the host writes and reads pixel color data through the ezVGA-LV graphics controller to the external video memory. All operations are done automatically via the on-board circuitry. Sync signals, video memory pixel reading and writing, continuous screen drawing, pixel counts, and line counts are all done automatically through the controller. The host only needs to know six instructions for complete operation. Communications to and from the ezVGA-LV graphics controller is done through an eight-bit data bus along with four address control lines. Having addressable control lines allows the ezVGA-LV to share a common system data bus with other devices. The ezVGA-LV offers a fast parallel interface and pixel read/write times of only 40-120 nanoseconds.

The ezVGA-LV graphics controller comes housed in a 100 pin TQFP package that conforms to JEDEC MO-047. The ezVGA-LV can be purchased by itself for $7.95 (single piece price). It can also be purchased with a video memory chip for $12.95 (single piece price). The video memory comes in a 32-pin TSOP II package. Quantity pricing is available.

For more information, contact:
Multilabs
Web: **www.multilabs.net**

JRK USB MOTOR CONTROLLER

Pololu announces the release of the jrk line of USB motor controllers: highly configurable, versatile devices that make it easy to add open- or closed-loop control of brushed DC motors to your computer- or microcontroller-based project. The jrk supports four interface modes: USB for PC-based control; logic-level (TTL) serial for use with embedded systems; analog voltage for simple potentiometers and joysticks; and RC pulse for radio control systems. It can perform open-loop speed control, closed-loop position control with analog voltage feedback to make your own servos, and closed-loop speed control with frequency feedback from a tachometer. The unit price is $49.95 for the jrk 21v3 (item #1392) and $99.95 for the jrk 12v12 (item #1393).

For more information, contact:
Pololu Corporation
Tel: **877-7-POLOLU**
Web: **www.pololu.com**

ROBOT CONTROLERS
up to 2x120A
RC, RS232, Ana In
Speed Mode
Position Mode
Tank Steering
Current Limitting
Field Upgradable
... and more
RoboteQ
www.roboteq.com

For parts under 2 Oz. We use low pressure hand operated presses, so the molds are very light weight and low cost. Up to 5,000 pcs per week.
VERY LOW COST CUSTOM PLASTIC PARTS
High volume production on hydraulic machines
www.dynamicdesignmexico.com

"THE PHANTOM DRAW"
The KILL A WATT meter is the best way to help you determine your actual energy draw in ON and OFF home appliances.
To order call 1 800 783-4624
or online www.nutsvolts.com
$29.95 plus S&H

SHOWCASE

ezLCD – The "Smart Display" Makes integrating a GUI ez!

3.5" ezLCD p/n: ezLCD+103

Versatile Programmable LCD module ▪ USB, SPI, RS232/TTL Interfaces ▪ Bright 350 Nit LED Display (320x240) ▪ Integrated Touch Screen ▪ LUA Scripting Language capable-For stand alone embedded applications ▪ Memory 3.8 MB + SD to 2G ▪ ezLCD's are also available in 2.7", 5.6", 6.4", 8.0", 10.4"

Call for Custom Display Configurations

earthlcd.com

Adapt9S12DP512

Our most popular board ever!

* University Programs/Senior Projects
* Flexible Modular Design
* Robotics/Mechatronics
* Free online resources
* RTOS-capable

$99 or less*

Program in BASIC, C, Assembler or Forth

* Educational discounts available

Evaluate * Educate * Embed

www.technologicalarts.com

USB Oscilloscope for $169.50

8+8 digital + 2 analog channels

Oscilloscope - Generator - Logic Analyzer with UART, SPI, I2C and 1-Wire interfaces

Great for PIC and AVR projects!

www.HobbyLab.us

QKITS.COM

Power Supply: 12/24VDC Load Voltage

30A PWM DC Motor Speed Control

Control the speed of your electric motors or the brightness of your DC light bulbs.

$24.95

Quantity discounts available.

1-888-GO-4-KITS

www.Primecell.com

Battery rebuilding service

Dead Batteries ? Don't toss them. Send them to us - our rebuilds are better than original specifications.

Tools: Hilti Skil Milwaukee Panasonic B&D DeWalt Makita All 2-36 Volts

Electronics: Bar Code Scanners Surveying Printers Laptops Photography

Radios: APELCO UNIDEN G.E. ICOM KENWOOD MOTOROLA MIDLAND MAXON YAESU ALINCO

Visit www.primecell.com for important details

24 Hr Secure recorder tel-fax (814) 623 7000

Quotes email: info@primecell.com

Cunard Assoc. Inc. 9343 US RT 220 Bedford PA 15522

BlinkM

Arduino

I2C RGB "Smart LED"

USB - BT - XBEE

Prototyping Supplies

Serial LCD

Save 5% with coupon code NV

FunGizmos.com

ActiveWire® USB

Simple USB Interface!

- Works with MacOS 8/9, Win98/2K/ME/XP FreeBSD and Linux!
- 24Mhz CPU core with USB
- Firmware downloadable via USB
- 16 bit parallel Input/Output
- See web-site for add-on boards
- All drivers, manuals, demos are on our web-site for immediate download!

$59 plus shipping

ActiveWire, Inc.

www.activewireinc.com

ph +1.650.465.4000 fax +1.209.391.5060

HYDRA

Game Development Kit

Develop Games, Graphics, and Media Applications with the Propeller™ Powered HYDRA Game Console Kit.

Master multicore technology & programming while having fun!

www.XGAMESTATION.com

Celebrating Our 10th Year Anniversary

ALL IN ONE Scope & Generator!

USB PC Oscilloscope & Function Generator (PCSGU250)

$238.55

USB PC Function Generator (PCGU1000) $242.85

USB PC Oscilloscope (PCSU1000) $298.99

DesignNotes.com

What Your Electronic Hobby Stores Used To Be

1-800-957-8867 www.DesignNotes.com

bob

basic overlay board

Display text and graphics from your microcontroller on standard TV monitors with BOB-4H.

DECADE ENGINEERING

Ph: 503-743-3194 | www.decadenet.com

Images Scientific Instruments Inc.

Bi-Directional Flex Sensors

This passive style sensor changes resistance as it is flexed in either direction!

Patent Pending

Applications Include:
Robotics
Bio-metrics
Virtual Reality
Exercise equipment

www.imagesco.com/sensors/flex-sensor.html

Explore FPGAs

Use a Baseboard-4 As Your Launchpad!

- Xilinx Spartan 3E
- Makefiles or GUI
- Linux or Windows
- Fast USB download
- Customize with a wire wrap card

www.demandperipherals.com

USB MEDIA PLAYER CONTROLLER

BY ROB CARUSO

I recycled a VCR knob assembly and turned it into a controller for the Windows Media Player.

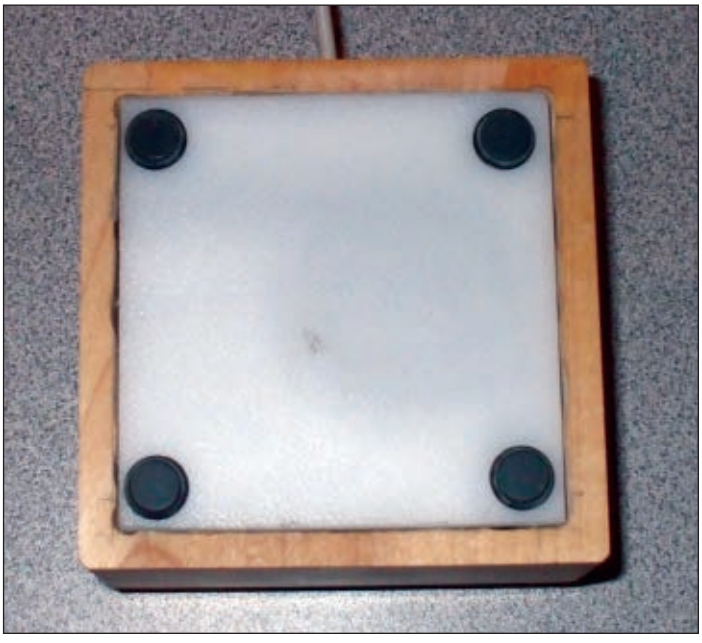
The knob assembly began its life as the control for a Sharp VCR. The VCR was given to me after it had stopped working. I let my son dismantle the unit because he enjoys opening things up and taking them apart. When the unit was disassembled, I took particular notice of the knob assembly — what it was comprised of, how it was assembled; I was impressed by how much control was put into such a small unit.

In the center of the device were three buttons for play/X2, stop/eject, and pause/still. Around the perimeter was a spring return dial which when rotated clockwise would fast forward and reverse when rotated counter-clockwise. It was refined to the point that a lot of thought must have had to been put into its design, and I knew that sooner or later it would end up in one of my projects.

The knob sat in the spare parts pile for awhile before the idea came to me to use it as a media player controller for my computer. While some keyboards have the media player controls built into them, my trusty old IBM model doesn't. (I still use this relic because I like the feel of the beefy keys when I'm banging away at them.) I had been meaning to do a USB based device and thought the combination of the knob assembly and a PIC16C745 programmed as a media player controller would make for a challenging and useful project. For those of you who may not be aware, the 16C745 is a one time programmable device with low speed USB built into it. If I were to build the controller today, I would make use of one of the full speed, Flash-based USB PIC controllers.

■ FIGURE 1. A close-up of the VCR knob and the wooden housing.

■ FIGURE 2. The assembled underside of the unit.

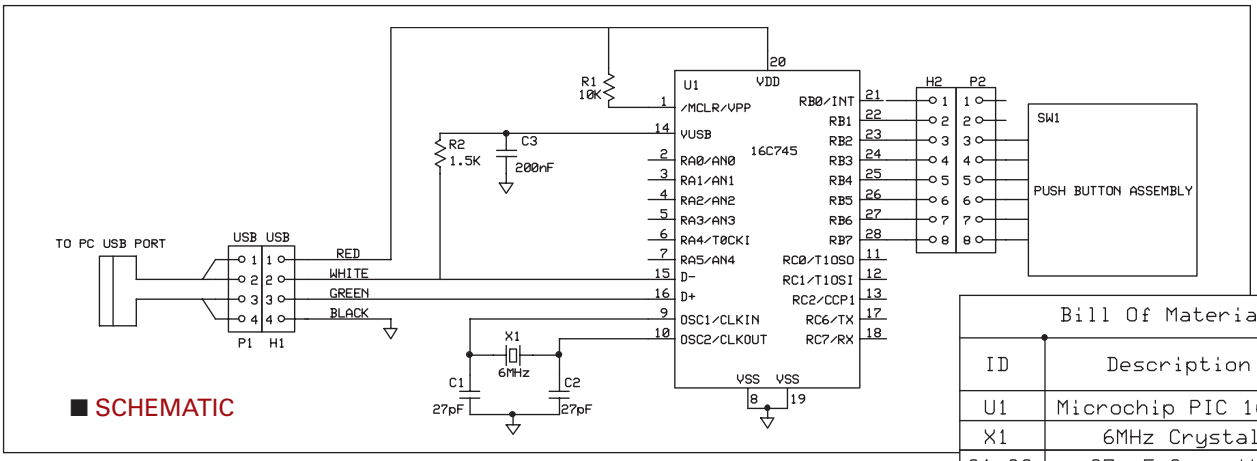


Functionality

The play/X2 button became the play/pause button while the stop/eject button became the previous track button; the pause/still button became the next track button. The forward/reverse dial became volume up and down, respectively. I did not try to relabel the buttons because the controls are so straightforward.

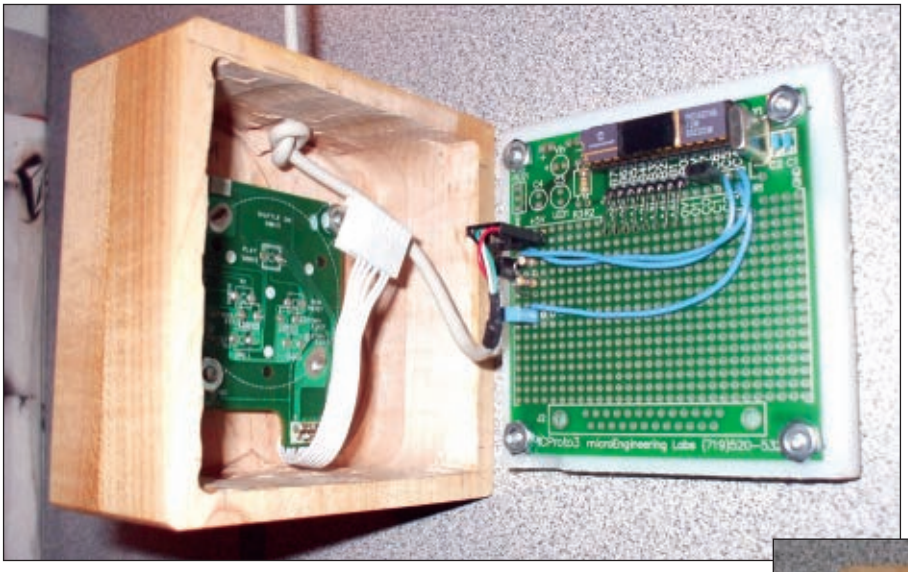
The hardware is simple and straightforward too (see the **schematic**) — a group of switches wired to a PIC programmed to send the required command codes to control the Windows Media Player through a USB port. The hardest part of the project was getting the device to enumerate properly.

I made use of a microEngineering Labs (**www.melabs.com**) PICPROTO 3 board on which to assemble the project. The USB cable is available from HVW Technologies (**www.hvwtech.com**); (SKU 14120) and features a series A USB plug at one end and a locking connector at the other. When the knob assembly was



■ SCHEMATIC

Bill Of Materials		
ID	Description	Qty
U1	Microchip PIC 16C745	1
X1	6MHz Crystal	1
C1,C2	27 pF Capacitor	2
C3	200nF Capacitor	1
R1	10K,1/4W,5% Resistor	1
R2	1.5K,1/4W,5% Resistor	1
P1	USB Cable - Custom	1
H1	Male Header - 4 Pos	1
P2	Female Plug - 8 Pos	1
H2	Male Header - 8 Pos	1
SW1	Play/Pause Knob Assm	1
-	Melabs PICProto 3 Bd	1



■ FIGURE 3. The unit opened up, showing the shuttle switch and USB cable on the left half, and the protoboard with microcontroller on the right half.

■ FIGURE 4. The VCR shuttle switch and USB cable in the maple housing. Note the drill marks from the forstner bits.

removed from the VCR, it had a unique connector attached to it. I removed the connector and soldered a short section of ribbon cable and an eight-pin connector to it to mate with the eight-pin header on the PICPROTO3 board. With the electronics complete, it was time to select a housing to put it in.

There were a lot of options to house the controller. I decided to put it into a wooden enclosure which I made from a solid block of sugar maple. This allowed me to make the enclosure as small as possible, making it just large enough to house the PICPROTO board and the knob assembly.

The block was drilled with forstner bits to hollow it out and to make the hole for the shaft of the knob assembly. (Drill the hole for the shaft from the outside first to prevent tear out). Next, I epoxied two screws to the inside of the hollowed block and fastened the knob assembly using nuts and lock washers.

After a bit of sanding, the block was finished with tung oil. The pins were removed from the locking receptacle and the USB cable was fed through a small hole in the housing. A knot was tied as a strain relief and the pins were put back into the receptacle housing. The board was mounted to a piece of polyethylene using threaded standoffs. The polyethylene was then "friction" fit into the wooden housing. A couple of rubber feet on the bottom and the unit was ready to rock 'n roll. **NV**

What interesting things have *you* made out of recycled components, pulled from electronics whose best days are behind them? Share your "recycled" creations with other readers and enter our Recycled Projects contest.

For details, go to **www.nutsvolts.com**.

RETRACTABLE MICRO-PROBE FOR FINE-PITCH IC ACCESS

BY DAVE SIEGEL

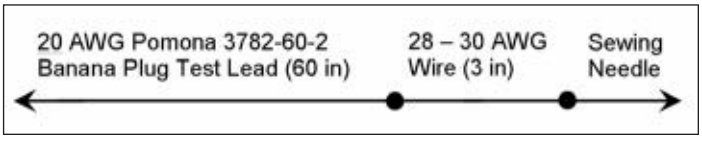
Surface-mount ICs and other electronic components are continually shrinking in size. This trend is reaching the point where basic meter measurements on ICs are a major challenge. Once the IC pin of interest is located (usually requiring magnification), more often than not, the test probe is too large to make the measurement without the risk of short-circuiting adjacent pins. Because conventional meter probes have changed little in size from the vacuum tube era, they are ill-suited for working with today's microscopic-size devices. Probing a .5 mm pitch surface-mount IC pin with a 2 mm probe invites disaster.

My work in electronics to a high degree involves fine-pitch surface-mount devices and, because of this, I frequently encounter the test probe/device size mismatch. A Google search showed that micro-sized test probes are available, but they are quite specialized and usually very expensive. I decided to design and build my own micro-probe.

The initial design consisted of a long embroidery needle with an attached wire lead. The opposite end of the lead was terminated with a standard banana plug. Heat-shrink tubing covered 90% of the needle, with only the tip exposed. The drawback of this simple design was that the finished probe was very difficult to hold and caused hand fatigue. Clearly, the needle required a suitable housing to be of practical use on a test bench.

A brainstorming session with paper and pencil produced the answer: Use a mechanical pencil for the housing of the micro-probe. The probe tip would, like the pencil lead, be retractable — a great safety feature. The design was finalized and a prototype soon followed.

■ FIGURE 1. Micro-probe schematic diagram.



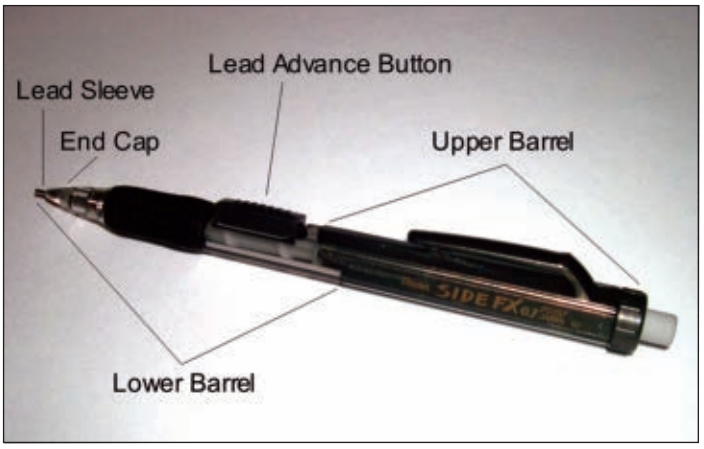
After several months of use, the micro-probe has proven itself an indispensable part of my test bench and feedback from colleagues using the probe has been very positive. I hope *Nuts & Volts* readers will enjoy building the micro-probe.

Construction

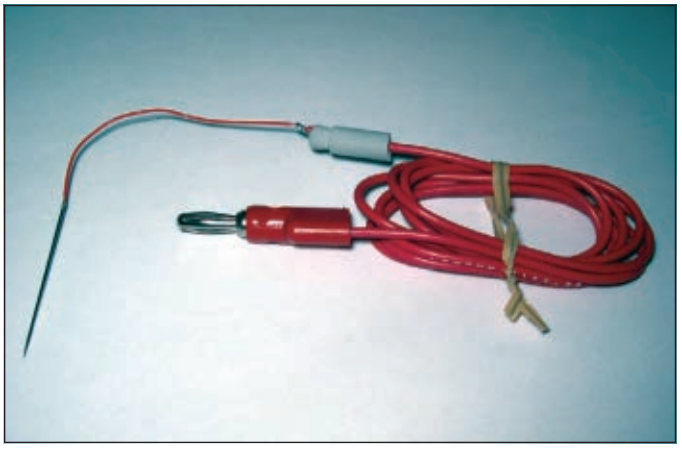
As the schematic in **Figure 1** shows, the circuit is very simple since there are no electronic components involved. The micro-probe is easy to build and can be completed in a few hours. I'll provide a very detailed assembly procedure for the benefit of less experienced hobbyists.

The dimensions given in the assembly procedure are specifically for the Pentel "Side FX" mechanical pencil, because the Side FX is inexpensive (about $2 each) and readily available. Other pencils will work, but wire length and needle dimensions may need adjusting. The selected pencil should have a side lead-feed button rather than a top feed because the pencil top is the exit point for the lead wire and must remain unobstructed. **Figure 2** identifies some of the Side FX components and it will be a useful reference during construction.

To begin, remove the lead from the pencil, then separate the top and bottom barrel sections by pulling them apart.



■ FIGURE 2. Anatomy of the Side FX mechanical pencil.



■ FIGURE 3. Micro-probe wiring.

Locate a Suitable Needle

Finding a suitable needle to work in the pencil proved to be the biggest challenge of the project. The two critical requirements for the needle are sufficient length and proper diameter. The needle must be at least 1.5 inches in length. This is to prevent the fine-gauge wire attached to the needle "eye" from interfering with the pencil's lead-feed mechanism. The needle diameter should be very close to 0.7 mm, the pencil's lead size. I tried several sewing stores unsuccessfully before finding the perfect needle at Wal-Mart – part of a forty needle assortment (see the **Parts List**).

Select a needle that looks similar to the thickness of the pencil lead. Measure the thickness with calipers or test the "fit" of the needle by holding down the side-advance button of the pencil and inserting the needle, point first, into the lead-sleeve. The needle should slide smoothly into the sleeve with little resistance until it approaches the eye of the needle, where it gets tighter (needles are thicker near the eye).

If the needle passes this initial test, remove it from the sleeve and drop it, point first, into the lower barrel of the pencil, as if loading a standard pencil lead. Click the lead-advance button a few times until the needle extends out of the sleeve by about 3/16 inch. Then, check the slippage by pushing down on the lower barrel with the approximate force you would use when probing a component. If the needle holds tight and does not slip back into the sleeve, it will be suitable for use in the probe. If it slips, find another needle. (As an aside, I have a few extra needles of the correct size available to *N&V* readers for just a SASE. Send an email to dsiegel@radexelectronics.com if interested.

Open a Wire Path Through the Upper Barrel

The lead-wire must pass through the eraser and the upper-barrel of the Side FX. To open a path, two holes are required: one through the eraser and the other through the upper barrel. Remove the eraser by rotating the eraser-advance ring in a clockwise direction to advance the eraser out of the eraser-holder. Pull out the eraser and snip off the top portion, leaving about 3/4 inch of the eraser bottom. Then, rotate the eraser-advance ring counter-clockwise until the eraser-holder retracts fully into the upper-barrel. Secure the 3/4 inch eraser bottom in a vise or hold it with pliers for safety. Carefully drill a 3/32 inch diameter hole straight into the center of the eraser through its entire length. Next, insert the drill bit into the empty eraser-holder and carefully drill a 3/32" hole through the center of the eraser-holder. At this point, you should be able to see light through the entire length of the upper barrel.

Wiring

Cut off the mini test-clip from the Pomona patch cord leaving about four inches of wire on the clip end. This leaves 56 inches of 20 AWG lead wire terminated in a banana plug. Route the lead wire through the eraser hole, leaving 1/2 inch of wire exposed at the eraser bottom. Strip 1/8 inch of insulation from this wire. Next, strip 1/8 inch from both ends of the 28-30 AWG 3 inch stranded wire. Tin the three wires and the needle eye with solder. Solder the lead wire to one end of the 3 inch wire. Then,

PARTS LIST

QTY	DESCRIPTION
❑ 1	Pentel Model Side FX 0.7 mm mechanical pencil or similar
❑ 1	Sewing needle — must be at least 1.5 inches long and close to 0.7 mm in thickness (Singer #30020 45 pc. hand needles, available at Wal-Mart)
❑ 1	30-32 gauge stranded wire, three inch length
❑ 1	Pomona #3782-60-2 mini test clip with banana plug, 5 ft. length or similar
Misc:	Potting compound or white household glue

■ FIGURE 4. Upper barrel assembly.

■ FIGURE 5. Finished micro-probe.

solder the opposite end of the 3 inch wire to the eye of the needle (keep the wire straight and use solder sparingly). The finished assembly is shown in **Figure 3**.

Assembly Procedure

Route the needle into the top end of the upper barrel, through the eraser holder, and out through the lower end of the upper barrel. Push the eraser all the way down into the eraser holder. Because we cut the eraser short, there will be empty space above the eraser. **Figure 4** shows the completed upper barrel assembly.

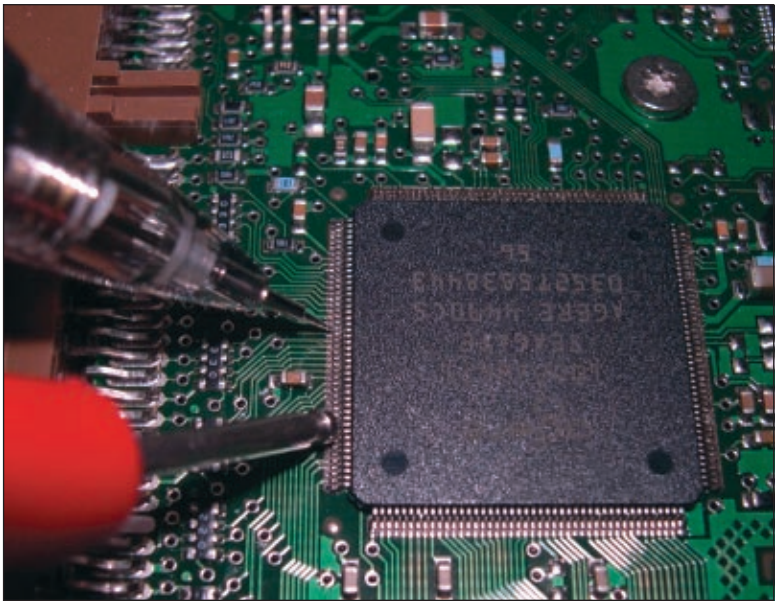
Drop the needle into the lead-feed mechanism. This is similar to loading a pencil lead, but a bit trickier because of the wire attached to the needle. Position the upper and lower barrels close together. Press and hold the lead-advance button while feeding the needle down into the lower barrel. Continue until the needle is visible in the transparent end-cap area. You may need to rotate the lower barrel back and forth while pushing on the needle to keep it moving, because you are pushing on a 28-30 AWG wire.

Once the needle reaches the end-cap, snap the upper and lower barrels of the probe together. Click the lead-advance button several times until 3/16 inch of the needle emerges from the sleeve. If the needle will not extend this far, the internal wiring may be too tight. If this occurs, push a bit more lead wire through the eraser. You might also try holding in the lead-advance button and gently pulling the needle out with pliers. Once the needle extends properly, verify that there is no needle slippage when using the probe and verify that the needle retracts fully into the sleeve. Test the probe for continuity with a meter. Resistance should be less than 0.5 ohms.

Potting

Fill the void in the eraser-holder with potting material to provide strain relief for the lead wire and to increase overall durability. I used white household glue because it was convenient, but RTV or other products will work just as well. Position the probe vertically in a vise. Center the lead wire and carefully fill the eraser holder with potting material. Let it set overnight and top it off if settling has occurred during the curing process. **Figure 5** shows the completed micro-probe. **Figure 6** shows the micro-probe and a standard Fluke probe next to a fine-pitch IC. Which tool would you choose to probe the pictured IC?

■ FIGURE 6. Micro-probe and standard probe size comparison.



Going Further

You can extend the versatility of the micro-probe by fabricating adapter cords such as a banana-jack to BNC, banana-jack to mini-clip, etc. With a BNC connector, for example, you can connect the probe to a function generator for signal injection. **NV**

Contact the Author

Dave Siegel is president of Radex Electronics, an SE Michigan design and fabrication firm. He has been active in electronics for a quarter century with interests in alternative energy and microcontrollers. He can be reached at dsiegel@radexelectronics.com.

ALL ELECTRONICS CORPORATION

QUALITY Parts
FAST Shipping
DISCOUNT Pricing

CALL, WRITE, FAX or E-MAIL for a FREE 96 page catalog.
Outside the U.S.A. send $3.00 postage.

12 VDC 1.5 A SWITCHING POWER SUPPLY

Input: 100-120Vac, 50/60Hz.
Output: 12Vdc 1.5A.
6' cord. 2.1mm coax power plug.
Center positive. UL.
CAT# PS-12151
$11.50 each

6-DIGIT, 24VDC COUNTER

KEP KT-979C. 6-digit, 24Vdc, 1.2W impulse counter. Advances one digit with each impulse. Non-resettable. 30 x 18 face x 42mm long. PC leads on 10mm centers. One threaded mounting hole on base.
CAT# CTR-8
$1.20 each

PRECISION GEAR MOTOR W/ SPEED CONTROL

Dunkermotoren
Motor: #BG40X50
24Vdc, 2.1A,
3640 RPM
40mm diameter x 100mm long.

Planetary Gearhead: #PLG42S
4:1 ratio 42mm diameter x 50mm long.
8mm diameter x 23mm long shaft.

Speed Control: #BGE40
Precision 24Vdc motor with gearhead and "piggy-back" PWM speed control with feedback circuit. Smooth operation from 0 to 900 RPM. Circuitry allows for start/stop (stop=dynamic braking/ start=max. possible acceleration) and direction CW or CCW. Motor speed control requires attachment of a 5K Ohm potentiometer (included). Motor has built-in protection for over/under voltage, thermal and stall.
CAT# DCM-346
$59.00 each

TILT - SWIVEL MOUNTING BRACKET

Sturdy, all metal mounting bracket. Perfect for small speakers, audio and communications devices. Tilt and swivel adjustment. Overall length of bracket is 4". Some mounting hardware included.
CAT# BKT-6
$4.50 each

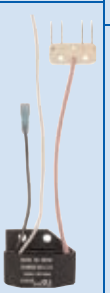
HYBRID STEPPER MOTOR

Minebea-Matsushita
23KM-K246-01V.
56 x 56 x 42mm hybrid stepper motor. 1.8 degrees per step. 0.25" diameter x 0.75" shaft. Four mounting holes on 1.86" centers. Detachable wire harness with four 12" wires. Motors are new, but may be scuffed due to improper packaging. Guaranteed functional.
CAT# SMT-116
$9.00 each

SOLAR CELL

Output: approximately 3 Volts @ 40 mA. 60mm square x 2.5mm thick epoxy-encapsulated silicon photovoltaic cell. Solid, almost-unbreakable module with solderable foil strips on backside. Ideal for solar-powered battery chargers and other projects.
CAT# SPL-61
100 for $3.25 each
$3.75 each

IONIZER



Seawise Industrial Ltd.
Model # SW750. Input: 120 Vac.
Output: 7.5 KV 60 Hz.
The main component in a household ionization unit. 2.2" x 1" x 0.86" thick with a mounting tab that extends 0.75" from the unit.
UL recognized.
CAT# SW-750
$4.50 each

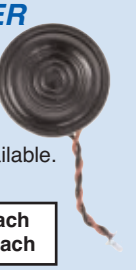
9VDC 62MM COOLING FAN

Micronel® #F62AB 009DN CK 9V. 9VDC 230 mA cooling fan. 62 x 62 x 14mm. 10 blade impeller. Fans are unused, but have been in storage for a while, and show some signs of age, ie., oil on label, no label. Guaranteed functional. Great price. Solder terminals/ fan plug. **CAT# CF-361**
5 for $1.00 each
$1.25 each

24VDC 6.5A POWER SUPPLY

Potrans #FS-15024-1M
ITE Power Supply
Input: 100-120V 4A
200-240V 2.3A
Output: 24Vdc 6.5A
150W switching power supply. Enclosed metal vented case. 7.875" x 4.35" x 1.96". Over voltage, over current and temperature protected. LED output indicator. Adjustable voltage output. UL, CE, TUV.
CAT# PS-6524
$24.95 each

8 OHM 40MM SPEAKER



40mm diameter x 6mm thick. 8 Ohm, general purpose speaker. 2" leads with 2-conductor female connector, 2mm centers. Large quantity available.
CAT# SK-840
75¢ each
10 for 70¢ each
100 for 60¢ each

LINEAR ACTUATOR

SuperJack® HARL 3618+. 36 Vdc. Linear actuator designed for positioning of large (1.2 - 3.6M) satellite dish antennas. Actuator travel is 18". Reed limit sensors. Weatherproof.
CAT# LA-3618
$34.95 each

Shop ON-LINE www.allelectronics.com
ORDER TOLL FREE 1-800-826-5432

MAIL ORDERS TO:
ALL ELECTRONICS CORP.
14928 OXNARD ST., VAN NUYS, CA 91411-2610

FAX (818) 781-2653 • INFO (818) 904-0524
E-MAIL allcorp@allcorp.com

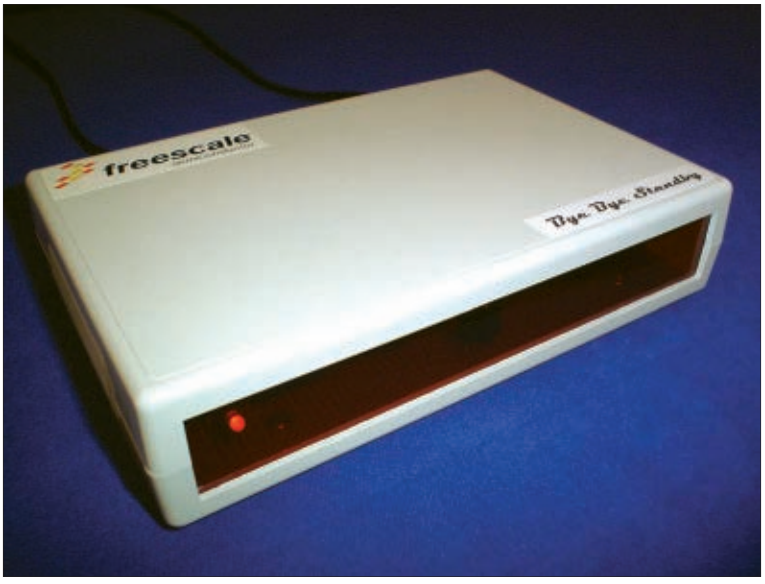
NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D • Shipping and Handling $7.00 for the 48 Continental United States - ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.

GREEN STANDBY

BY CARLOS COSSIO

There are still millions of older and not so old appliances that waste too much energy in standby mode. The device described here helps to save energy without compromising usability.



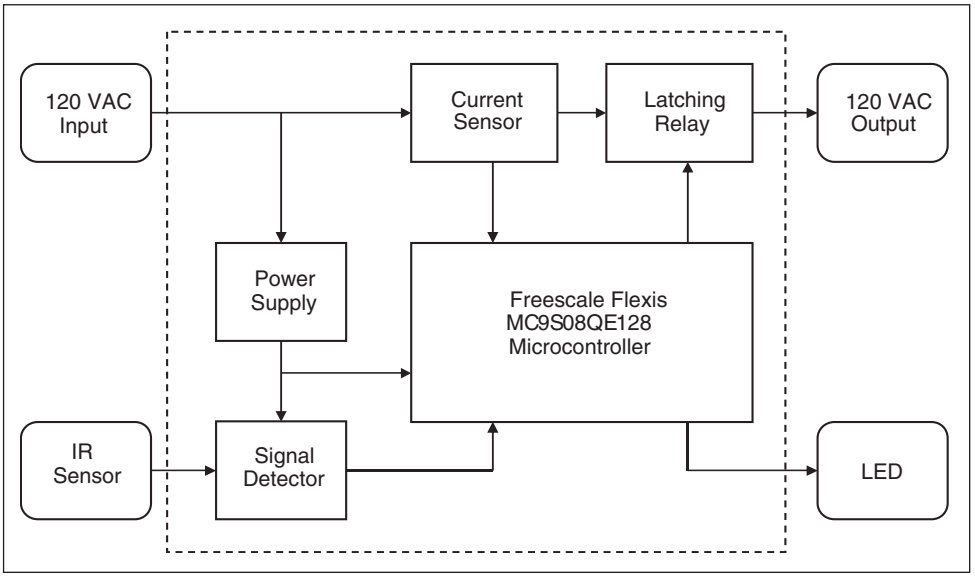
■ FIGURE 1. This is the Green Standby device in action. Just plug in the appliance in the back and connect it to the grid to start saving energy!

Most of today's home appliances have no genuine off switch. They are instead equipped with standby circuitry over which users have no direct control. The main power switch controls only the low voltage circuitry and even when the machine appears to be turned off, it is still consuming a few watts of energy without any purpose.

Although solutions do really exist like the switchable mains outlet strip, they have a distinct disadvantage in home entertainment applications: Convenience vanishes if you can no longer switch the device on or off simply by zapping it with the remote control handset. Solutions of this kind have the key advantage that hardly any power is ever wasted on standby current. The downside is that you can no longer wake up the appliance with its remote control. With these semi-intelligent standby switches, you need to press an onboard button to rouse them again, wiping out half the attraction.

The proposed device (see **Figure 1**) reacts to virtually any key press of almost every infrared remote control on the market. It enables you to upgrade an existing appliance with poor standby characteristics, reducing standby current very significantly. It doesn't need installation or any configuration.

The interface to the outside world comprises a 120 VAC mains input and output together with an infrared sensor and a power supply. When a button is pressed on the infrared handset and is registered by the IR sensor, the signal detector delivers a trigger pulse to the circuit's microcontroller. This operates the relay and the 120 VAC outlet is powered. Additionally, current flow is monitored for a number of seconds. If the microcontroller



■ FIGURE 2. High level block diagram of the Green Standby.

■ FIGURE 3. Here is the flowchart of the application. Most of the time, the Green Standby is in a deep sleep mode, helping to consume only around 50 mW when idle.

recognizes normal operation, the relay remains activated. If the current drops below a preset threshold level, the relay is deactivated after a few seconds and the mains outlet is powered down. See **Figure 2** for a detailed block diagram.

Good for the Environment

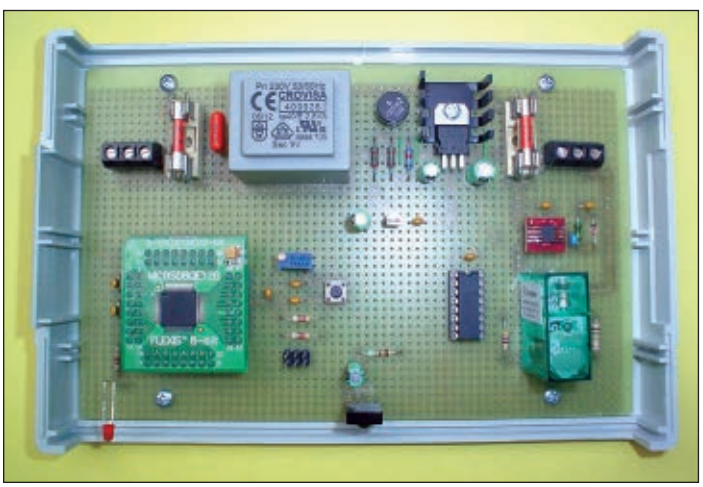
Standby mode of operation refers to the lowest power consumption mode which cannot be switched off by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions.

Standby power is a relatively new phenomenon. An ever-growing number of consumer goods and appliances are now designed in a way that they draw power 24 hours a day, seven days a week, every week of the year.

Standby is often necessary to power certain core functions or to sense communication for those products that are waiting to provide full services. This power is consumed not while the appliance is being fully utilized, but while it awaits instruction. However, in many cases, standby power serves no useful function or operates at excessive levels.

Some studies estimate that the amount of energy wasted by running dormant devices left plugged in on standby power could light up, heat, and cool the homes of two-thirds of the planet. In the latest big study to track household energy use, the Australian government last year found that households squander 10 percent of their electrical bill on electronics that invisibly suck power.

As an example, other studies appraise that the annual collective standby power draw from households in the USA is around 8 Gigawatts — equivalent to the electricity production of eight large power plants. Globally, standby power consumption is estimated to be responsible for about 1% of the world's carbon dioxide emissions.



■ FIGURE 4. Close-up view of the Green Standby's internal circuitry. The hardware is so simple because the number of active components has been reduced in order to lower the total system power consumption.

Think about it. We could reduce 1% of the amount of carbon dioxide being spewed into the environment just by switching appliances off when not in use and all save some money on each power bill in the process!

How It Works

The installation procedure is really simple. There are not switches or complicated setup procedures to follow. As an example of use for a TV, simply connect the TV plug into the 'Green Standby' socket and finally connect the Green Standby to the power grid. A truly plug and play device!

As soon as the Green Standby is plugged into the mains, it flashes the red LED to show that the initialization process has finished successfully and enters in a much reduced power mode, waiting for a key press from the wireless infrared remote controller. Then, as soon as a key press is sensed, it wakes up and switches the TV on so you can choose your favorite channel to watch. Any subsequent key press from the wireless remote controller does not affect the Green Standby.

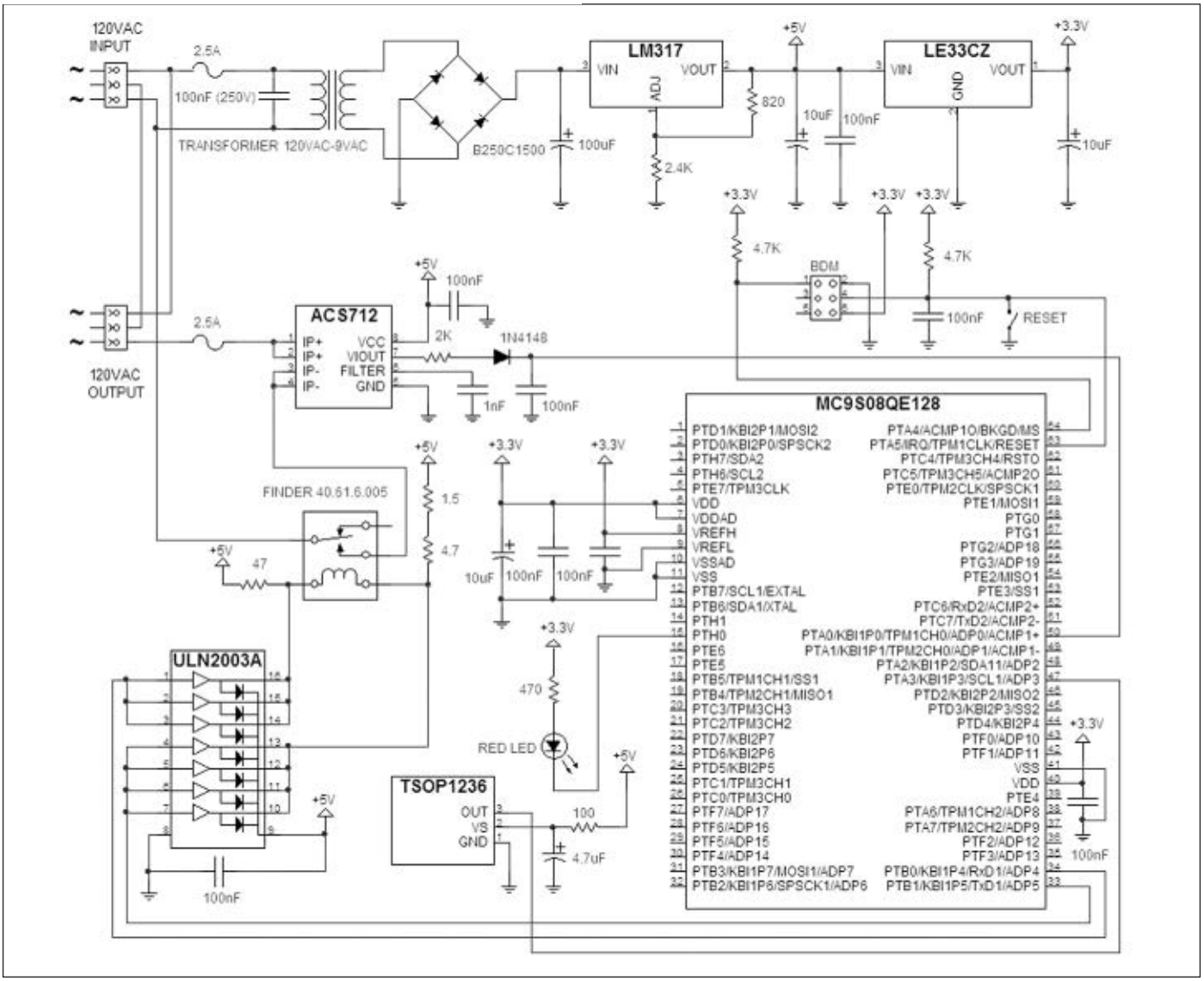
When the standby device is on, it is continually monitoring every half a second if the TV has been switched off by the user. If this is the case, it waits for five seconds to definitively switch the TV set off and enters into sleep mode, waiting for a new key press. See **Figure 3** for a functional flowchart description.

Circuit Description

The hardware design (**Figure 4**) is built around the Freescale Flexis eight-bit MC9S08QE128 microcontroller. It has an impressive low power operation mode as required by this application. The use of the low power mode in the microcontroller allows a significant reduction in the overall power consumption.

All the hardware design is oriented to low power

■ FIGURE 5. Here is the board's schematic based on the Freescale Flexis eight-bit MC9S08QE128 microcontroller.

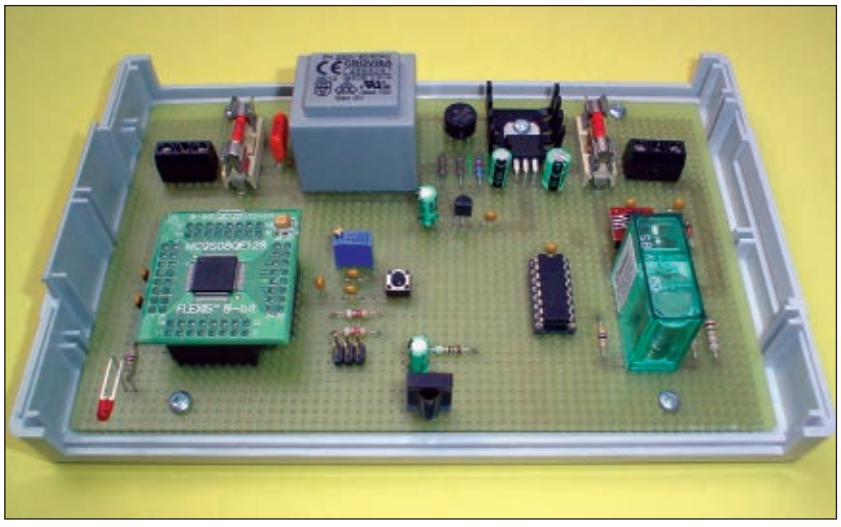


consumption from the beginning. As a rule of thumb, the best way to reduce the overall power consumption is to minimize the number of active and passive components, as well as to choose low power components. **Figure 5** shows the hardware schematic.

The type of power supply is an important issue for energy conservation. So, instead of using a conventional fixed voltage regulator such as the LM7805 with a residual current of up to 6 mA, I opted for a standard adjustable voltage regulator such as the LM317. It delivers a stable output voltage with a quiescent current of just around 1.5 mA. To power the microcontroller at 3.3V, I selected the LE33CZ fixed low dropout voltage regulator from ST Microelectronics with a quiescent current of just 1.5 mA. For further energy-saving considerations in the power supply, you can use a low overhead regulator, but take into account that they are more expensive and difficult to find. With respect to the transformer, although they have improved continuously over the past years, they still have some losses. So, using a good quality transformer makes good sense.

For the relay used, I decided to use a single-coil latching relay instead of a classic relay. This relay can pose a design challenge because coil current must flow in both directions through a single coil. Current flowing from a positive pin to negative pin causes the relay to latch in its reset position. On the contrary, current flowing from a negative pin to positive pin latches the relay in its set position. The relay maintains its position even when the coil current is removed, so power is saved by removing coil current after the relay latches.

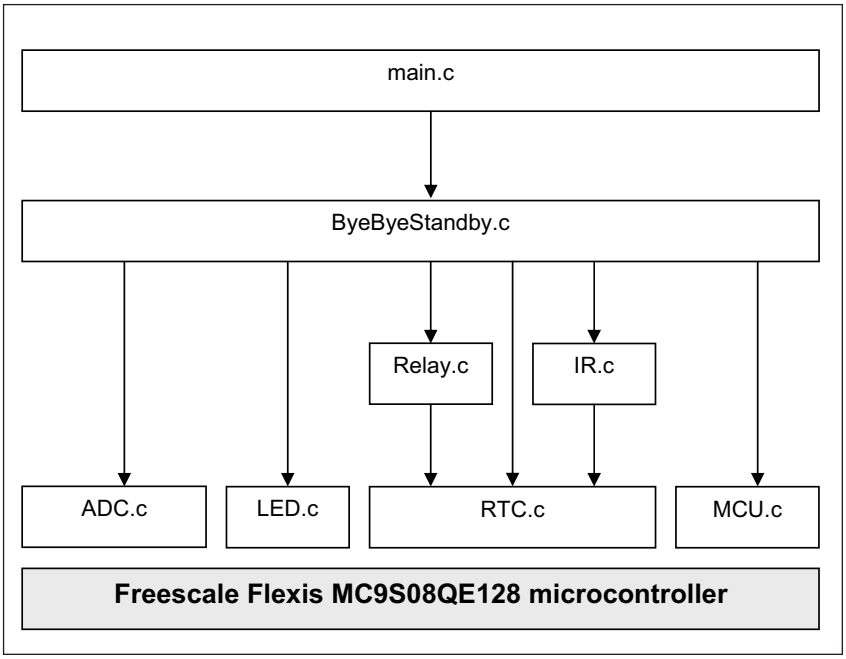
The main advantage of a latching relay over a classic relay is that as soon as the relay has switched, it remains in that position without consuming energy. So, no current consumption means less heat production, hence smaller heatsinks. Best of all is a dramatic



■ FIGURE 6. Although initially the hardware was designed to work at 230 VAC (European standard), it can be easily modified for operation at 120 VAC (US standard) by changing the transformer.

PARTS LIST

PART	QTY	DESCRIPTION
❑ MCS9S08QE128	1	Freescale Semiconductor Flexis eight-bit microcontroller
❑ Transformer 120 VAC to 9 VAC	1	120 VAC – 9 VAC voltage transformer
❑ Finder 40.61.6.005	1	Finder single-coil latching relay
❑ ACS712-05	1	Allegro Systems Hall-effect current sensor (5A)
❑ TSOP1236	1	Vishay Semiconductors IR receiver module for remote control
❑ ULN2003A	1	ST Microelectronics relay Darlington buffer
❑ LM317T	1	National Semiconductor three-terminal adjustable voltage regulator
❑ LE33CZ	1	ST Microelectronics low-dropout 3.3 voltage regulator
❑ B250C1500	1	Full bridge rectifier
❑ 2.4K Ω	1	1% precision resistor 1/4W
❑ 820 Ω	1	5% resistor 1/4W
❑ 4.7K Ω	2	5% resistor 1/4W
❑ 2K Ω	1	1% resistor 1/4W
❑ 47 Ω	1	5% resistor 1/4W
❑ 4.7 Ω	1	5% resistor 1/4W
❑ 1.5 Ω	1	5% resistor 1/4W
❑ 100 Ω	1	5% resistor 1/4W
❑ 470 Ω	1	5% resistor 1/4W
❑ 100 µF	1	Aluminum electrolytic capacitor 16V
❑ 10 µF	3	Aluminum electrolytic capacitor 35V
❑ 4.7 µF	1	Aluminum electrolytic capacitor 63V
❑ 100 nF	8	Ceramic film capacitor
❑ 100K250	1	MKT capacitor
❑ 1 nF	1	Ceramic film capacitor
❑ LED	1	Red LED
❑ 1N4148	1	Fast switching diode
❑ Fuse 2.5A	2	Fuse
❑ Fuse holder	2	Fuse holder
❑ Switch	1	Micro pushbutton
❑ Six-pin header	1	BDM six-pin connector
❑ Three-pin AC power PCB connector	2	AC power connector



■ FIGURE 7. The module hierarchy in the software design is fairly simple. There are different layers of complexity. Each microcontroller peripheral has its own driver in a separate source file to improve maintainability.

decrease in power consumption. In addition, the relay driver is built around a standard ULN2003A Darlington driver instead of using a half-bridge circuit. This simplifies the hardware.

There are several options available for the current sensing method used. The load current can be sensed by either using a current transformer or by passing the current through a very small resistor and then measuring the voltage across this resistor. As an advantage, a current transformer offers isolation through the transfer of current from the primary to the secondary winding. It can also handle higher currents than a

TABLE 1

Module	Description	Functions
Main.c	This is the main program	main (...)
ByeByeStandby.c	This file contains the set of functions necessary to build the 'Bye Bye Standby' application	ByeByeStandby_Init (...) ByeByeStandby_Welcome (...) ByeByeStandby_On (...) ByeByeStandby_Off (...) ByeByeStandby_Mode (...) ByeByeStandby_InfraredRemote ControlKeyPressed (...) ByeByeStandby_PeripheralInStandby Mode (...) ByeByeStandby_Sleep (...)
ADC.c	This file allows to manage the ADC converter driver	ADC_Init (...) ADC_Start (...) ADC_Read (...) ADC_Stop (...)
LED.c	This file allows to manage the LED driver	LED_Init (...) LED_On (...) LED_Off (...)
IR.c	This file allows to manage the IR receiver driver	IR_Init (...) IR_Enable (...) IR_Disable (...) IR_Mode (...) IR_ISR (...)
Relay.c	This file allows to manage the latching relay driver	Relay_Init (...) Relay_Open (...) Relay_Closed (...) Relay_Mode (...)
RTC.c	This file allows to manage the Real Time Clock driver	RTC_Init (...) RTC_Start (...) RTC_Stop (...) TC_Delay (...) RTC_Enable (...) RTC_Disable (...) RTC_ISR (...)
MCU.c	This files allows to initialize the microcontroller resources	MCU_Init (...)

resistor and consumes less power.

However, current transformers are more expensive and less accurate than resistors. Another disadvantage of current transformers is that the core can saturate in large current applications making the device highly non-linear, thus causing measurement errors. On the other hand, I discarded the use of a resistor as a current sensor because it might cause other nearby components to overheat.

In addition, both solutions need additional active components for signal conditioning and amplification. So, I decided to use an integrated Hall-effect chip such as the ACS712 from Allegro Microsystems. Its output can be directly connected to the analog to digital converter of the microcontroller, reducing the number of components and hence power consumption.

The IR sensor and signal detector are combined in the monolithic TSOP1236 IR receiver module from Vishay Semiconductors working at 36 kHz which is the standard frequency used in most of the wireless infrared remote controllers available on the market.

Additionally, there is an activity red LED to show when the device is switched on.

Finally, there is a standard Freescale six-pin BDM connector for in-system programming in order to update the Flash memory in case further updates or enhancements are planned in the future.

Summarizing, the entire electronics (**Figure 6**) draw less than 50 mW. Compared with the energy wasted by conventional standby equipment (around 3W), this is truly negligible!

Firmware Design

The microcontroller tools used to develop the Green Standby firmware were Freescale CodeWarrior version 6.2 and the P&E Multilink interface for debugging and programming the Flash memory. To download CodeWarrior Special Edition and test a trial version of the C-compiler, visit the Freescale website at **www.freescale.com**

All the software has been developed in C in a modular way so that maintenance and improvements are fairly simple to do. A module hierarchy of the design is shown in **Figure 7**.

Table 1 gives a brief description of each module and its hierarchy in the design. For more detailed information, you can take a look at the source code provided at **www.nutsvolts.com**.

Green Electronics

Green electronics is becoming an increasingly popular design trend. The importance of hardware that is environmentally friendly is gaining attention worldwide.

You have learned how to use the low power modes available on modern microcontrollers' architecture so that with the help of a very basic firmware algorithm, your hardware can be considered as green electronics. In addition, you have also learned how to use a single coil latching relay instead of a classic relay in order to reduce the total power consumption of the system.

There is definitely room for improvement. For instance, you can modify the hardware to handle more than one appliance at the same time using just one wireless remote controller, making the Green Standby a true multi-appliance device controller. **NV**

Resources

MC9S08QE128 Datasheet
Freescale Semiconductors, 2007

MC9S08QE128 Reference Manual
Freescale Semiconductors, 2007

DEMOQE128 User Manual
PE Micro, 2007

USB HCS08/HCS12 Multilink Technical Summary
PE Micro, 2007

ACS712 Fully Integrated Hall-Effect Based Linear Current Sensor Datasheet
Allegro MicroSystems, 2007

LExxC Very Low Drop Voltage Regulators With Inhibit Datasheet
ST Microelectronics, 2007

LM117/LM317 Three-Terminal Adjustable Regulator Datasheet
National Semiconductor, 2007

TSOP12xx IR Receiver Modules For Remote Control Systems Datasheet
Vishay Semiconductors, 2007.

ULN2003A 5-V TTL Seven Darlington Arrays Datasheet
ST Microelectronics, 1991

40 Series Miniature PCB Relays 8, 10, 16A, Finder, 2008

About the Author

Carlos Cossio (ccossio@hotmail.com) earned a B.S. in Physics (majoring in electronics) at the University of Cantabria in Spain. He is a senior smart card engineer with more than 15 years of experience designing trusted security platforms. In his spare time, Carlos enjoys repairing and bringing old electronics equipment to life.

The design described in this article was chosen as a top five finalist in the European first Green Freescale Technology Forum Design Challenge 2008.

Experiments with Alternative Energy

Part 3 - Build a Solar Powered Battery Charger

By John Gavlik, WA6ZOK

Welcome back to our continuing series of articles on alternative energy experiments that are designed around the Parallax BS2 and PICAXE 28X2 microcontrollers. This time, I'll show you how to build a solar powered battery charger – actually two of them. You can find all the details on my website at **www.learnonline.com**. Just click on Experimenter Kits on the menu links and select "Build a Simple Solar Powered Battery Charger."

Experiments that complement this article can be viewed in their entirety and downloaded from the Experimenter Kits section of the LearnOnline website or the Media Downloads section of *Nuts & Volts*.

www.learnonline.com
www.nutsvolts.com

Experiments with Alternative Energy

Remember, these experiments are designed to introduce you to the fundamentals of alternative energy like solar, wind, and hydrogen, and how to apply them to model, real-world devices that you build and program around two of your favorite microcontrollers. They are meant to give you a starting point in your microcontroller design cycle so that you can improve on what is presented in order to optimize the hardware and firmware to your particular needs and wants. Along the way, it should improve your understanding of alternative energy including devices like rechargeable batteries that use it.

Ni-Cad, NiMH, Li-ion - Choices, Choices, Choices

The variety of rechargeable batteries available these days is quite remarkable, and the choice of which one to use is getting more difficult. Nickel-Cadmium (NiCad) varieties have lost ground to newer, more energy dense types like Nickel-Metal Hydride (NiMH) and Lithium-ion (Li-ion). These don't have the dreaded and sometimes disputed "memory effect" of NiCads that shorten the life of portable electronics. Li-ion batteries are also better in that they don't suffer from this condition, along with having a low self-discharge rate of approximately 5% per month. This is compared with over 30% per month for some common NiMH batteries (which is why your digital camera doesn't work and needs a recharge after leaving it on the shelf for an extended period of time).

That said, for our solar powered battery charger I've chosen to use NiMH cells because they are relatively inexpensive and don't suffer the thoroughbred shortcomings of Li-ion batteries (such as explosions if overheated by overcharging or that they may become irreversibly damaged if discharged below a certain voltage). Their internal resistance is higher than NiMH types and increases with both cycling and age – another permanent reaction. Rising internal resistance causes the voltage at the terminals to drop under load thus limiting the maximum current that can be drawn from them. Eventually, they reach a point at which they can no longer

operate the equipment they are trying to power; kind of like the older NiCads but for different reasons. Lithium-ion technology is here to stay, but it's still a work in progress.

Battery Capacity — C

Battery capacity, labeled as the letter "C," is the battery's current-energy rating as in 2,450 mAh (milliamp-hours). I used an Energizer AA size, model NH15BP-2 for testing. That means this particular battery can (theoretically) produce 2,450 mA for one hour, or 4,900 mA for 30 minutes, or 9,800 mA for 15 minutes (I doubt it). In reality, batteries do not respond in such a linear fashion. Battery manufacturers typically specify a discharge load of 0.1C or one-tenth of current capacity when rating their batteries; then they simply multiply this number by 10 for the published rating. Therefore, a battery that can deliver 245 mA for 10 hours will be rated at 10 x 245 or 2,450 mAh as in our test battery — specsmanship at its best or worst depending on your point of view.

The value of 0.1C has been chosen by manufacturers as it illustrates battery capacity in the best light because of the lower discharge value. A faster discharge rate will most certainly result in less energy being available from the battery, and therefore the measured capacity will be lower. It's like specifying fuel mileage for cars; you can't get the same range or mpg if you drive 70 mph versus seven mph. So, who can you believe — their specs or your tests?

Setting Up the Test Bed

You can determine the battery capacity under load by carefully discharging the battery while measuring the power at specific time intervals. However, you can't do it unless it's charged to some degree. This, then, brings us to the first phase of our experiment: charging the battery — slowly and carefully so as not to damage it. The hardware setups are illustrated in **Figure 1** and **Figure 2** for the Parallax BS2 and PICAXE 28X2, respectively. You will need to wire the circuit and download the firmware to the micro.

Note: If your battery is already fully charged or partially so, it is best to discharge it to approximately 0.25 volts (but not 0 volts — never fully discharge it) using a 10 ohm resistor before going to the next step. Use the test bed setup in **Figure 3** or **Figure 4** to monitor the voltage levels. It basically swaps the battery for the solar panel as the voltage source and uses the 10 ohm load to discharge the battery. You can monitor the voltage level on the computer. Return to the test bed setup in Figure 1 or Figure 2 when the battery is discharged to about 0.25 volts.

Part 1: Manual Charging

Set up the test bed in Figure 1 or Figure 2 in full sunlight and allow the battery to begin to charge. **Figure 5** shows the beginning of a normal charge cycle with the nominal voltage and current flowing from the solar panel into the battery. Notice that the battery voltage is above the 1.2 volt rating during charging; this is normal. Also notice that the current from our small solar panel is about 126 mA, which is a trickle charge level. Since our test battery is rated at 2,450 mAh, it will take about 24 hours "in the bright sun" to completely charge it at this small current level. Therefore, the charging cycle may have to be extended over several days to acquire a full charge. The charging time is totally dependent on your solar panel's voltage and current capability. If you use a larger panel with greater current output, the charge time will be less. All things considered, it won't hurt if you never get it to a fully charged state. Again, NiMH batteries don't suffer the memory effect of partial charging so don't be concerned.

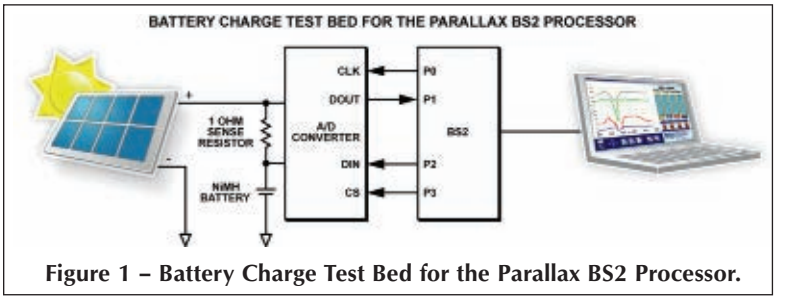


Figure 1 – Battery Charge Test Bed for the Parallax BS2 Processor.

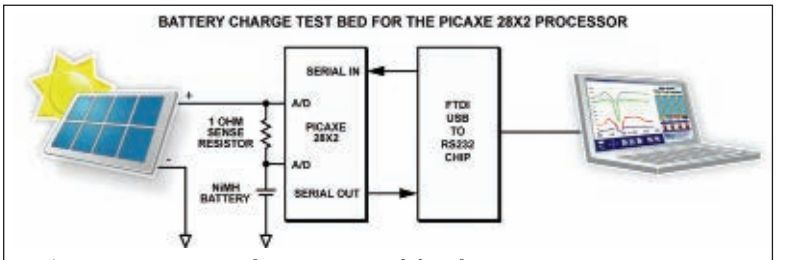


Figure 2 – Battery Charge Test Bed for the PICAXE 28X2 Processor.

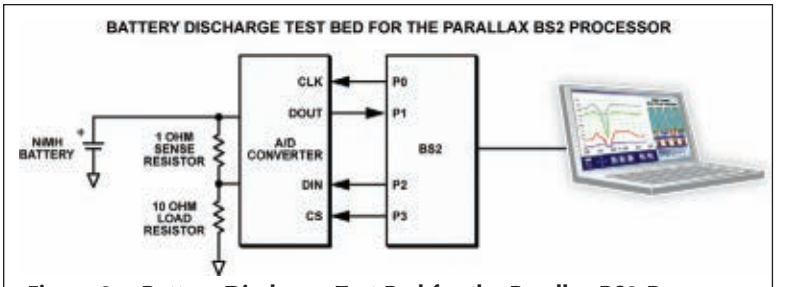


Figure 3 – Battery Discharge Test Bed for the Parallax BS2 Processor.

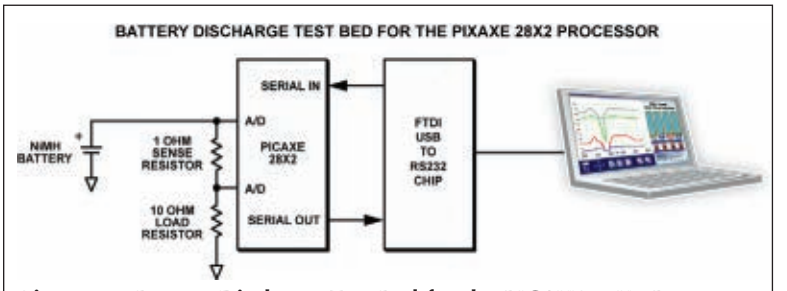


Figure 4 – Battery Discharge Test Bed for the PICAXE 28X2 Processor.

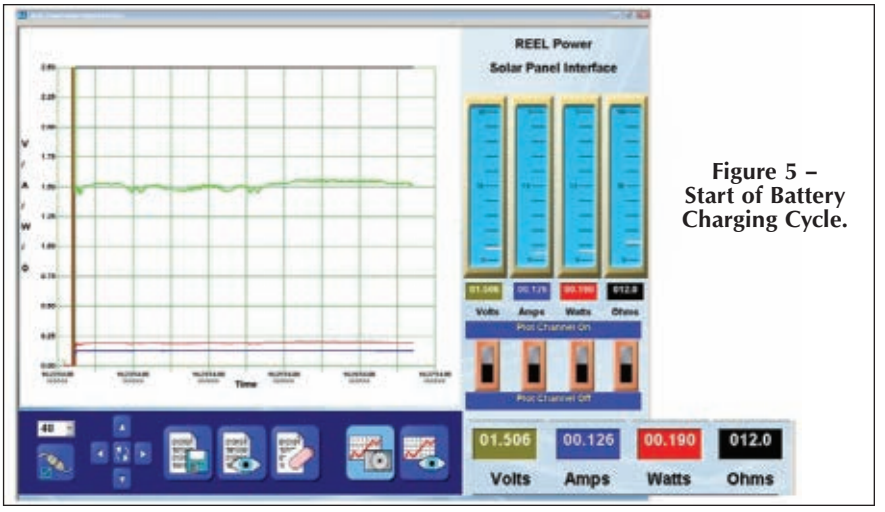


Figure 5 – Start of Battery Charging Cycle.

Figure 6 shows what to look for as the battery reaches its fully charged state (if you have the time and patience to do so). Notice the slight peak in the voltage (solid plot line) before it dips back again; this means that the battery has reached its fully charged state. You will generally find this type of noticeable peak when the battery is being charged at 1C or more. If you are using a solar panel that delivers this kind of amperage, this is what to expect. Otherwise, you will experience plots like those with the dashed and dotted lines at lower currents. With lower currents, the voltage peak is much less pronounced and is even non-existent at very low trickle rates like our small solar panel produces.

Delta-V or Delta-T

We've already seen an example of Delta– V or the "change in voltage" in Figure 6 that indicates the end of the charge cycle. After the cell is fully charged and as it begins to overcharge, the voltage polarity of the electrodes inside the battery will begin to reverse, and this will cause the battery voltage to peak then decrease slightly. However, a disturbing characteristic about NiMH batteries is that "false" Delta– V events can occur before the real one does. New NiMH batteries can exhibit these voltage peaks early in their cycle, especially when they are cold (see Figure 5). So much for battery designers making it simple for us common folk to design battery chargers for them; but that's the fun part, right?

Another method of detecting the end of charge is by using a temperature probe on the battery and looking for Delta– T or the change (rise) in the cell temperature. However, this is for high current, fast charge systems. Since we are trickle charging our batteries with the small solar panel, there is no need to do this; however, I wanted to make you aware of it should you ever want to use a larger, more powerful solar panel for charging. Just remember: As with solar panels, heat is the enemy of batteries, so keep things cool.

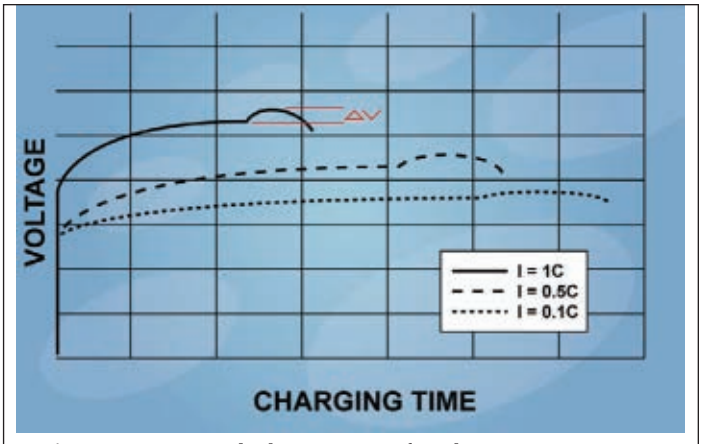


Figure 6 — General Charge Curve for Three Current Inputs.

One at a Time or All Together

Another "gotcha" about NiMH batteries (unlike Lithium-ion or lead acid) is that you just can't detect when the battery is fully charged by monitoring the voltage alone. Nickel metal hydride batteries like nickel cadmium don't have a "float charge" voltage; they are current-based animals and, as such, each cell needs to be charged individually — not in series or parallel like lead acid or Lithium-ion — especially when using a high current charge. Take this into account if you build a multi-cell charger, because some cells will take on more current than others even when they are completely charged! This means battery damage will occur and about the only thing to do is balance the current input in some way, like using resistors in series with "each" battery in order to limit the current. Again, we won't worry about this for our simple one cell charger, but just be aware of this for future reference.

Part 2: Measuring Battery Capacity

With a fully or partially charged battery, now comes the second phase of our experiment: measuring battery capacity. For this test, we want to measure power into a resistor load over a specific amount of time, a.k.a., energy. The battery's mAh rating is not particularly useful in the real world as pointed out earlier. Instead of mAh, we want wH or watt-hours, since a watt (voltage x current) takes into account any variation in battery voltage, as well as current, and gives a truer measure of instantaneous power, as well as power over time (energy).

In order to measure the battery's stored energy, we will apply the same 10 ohm resistor load and periodically measure the power at set time intervals. This will be easy with the graphic software since all we need to do is hook things up and watch what happens. A feature of the graphic software allows you to capture an entire screen image for later viewing and analysis. This saves trying to copy down the voltage, current, power, and resistance

values manually. Just click the Screen Capture icon (**Figure 7**) and a snapshot of the screen is captured and saved to the hard disk.

To view the snapshot, click on the Screen View icon (**Figure 8**) and use the small arrow keys at the bottom of the snapshot to scroll back and forth among the images. This is a great way to do any of the experiments in this series — especially the ones where data changes rapidly. **Figure 9** shows a typical captured screenshot overlaid on the real-time plot.

Take a snapshot once every minute while the battery discharges. Then, add up the power readings and divide by the number of samples taken. The average power is now in watt-minutes. To convert to watt-hours, simply divide watt-minutes by 60. With either value, you have a true indication of the amount of total energy available in the battery – for the 10 ohm load, that is.

To be thorough about this, you should repeat the charge-discharge cycle several times to verify your findings, and in so doing, change the load resistance to something like five ohms or three ohms. For new NiMH batteries, it is necessary to cycle them three to five times before they reach peak performance anyway. This will show how well the battery performs under heavier loads which are common in model cars with DC motors that stop and start, go slow and fast, and travel up and down as they do, the motor's resistance changes which causes more or less power to be absorbed from the car's battery. As my college professors used to say "Proof left to student." It got them off the hook for actually explaining things and put the onus on the students to do the grunt research work. Except this time it will be worth it to you to charge and discharge the batteries with different loads to fully understand the concept of battery capacity. Plus, you'll improve your battery's overall performance, as well.

Figure 7 – Screen Capture Icon.

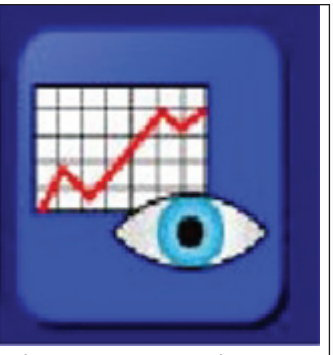


Figure 8 – Screen View Icon.

Part 3: Building an "On-Demand" Solar Powered Battery Charger

With all this background information, you can now feel confident about knowing what to anticipate in terms of how a NiMH battery will behave and what an automatic battery charging circuit should do. The front end of our version is illustrated in **Figure 10**.

You will notice that I added an NPN transistor, Q1 (a 2N3904 or 2N2222 — your choice), between the solar panel and battery that acts like an ON-OFF switch to allow current to flow (or not) from the solar panel into the battery. Q1 is turned ON by setting the output pin connected to the 470 ohm base resistor to a HIGH. This allows current to flow from the solar panel into the battery in order to begin the charging cycle. Q1 is turned OFF by setting the output pin to LOW. I've also added an LED and another 470 ohm current limiting resistor to indicate when charging is taking place.

By "on demand" I mean the firmware will first test the battery for its voltage level and then decide whether or not to turn Q1 ON. If the battery is above the "full discharge" voltage (as indicated by a constant in both firmware code versions), Q1 will remain OFF and the battery will be allowed to discharge into the load. When the battery reaches the full discharge voltage, Q1 is turned ON and the battery is allowed to charge until it reaches *and maintains* the "full charge" voltage for a period of time. You will notice that the full charge and discharge voltages are far apart enough so that "toggling" between charging and no charging is avoided. The technical term for this is called "hysteresis." Plus, the firmware has a timing loop to help prevent this, as well.

How the Code Works

The firmware that handles the battery charging is explained next. You will need to refer to the code and the algorithm in **Figure 11** to follow along. Code files are listed at **www.learnonline.com** and **www.nutsvolts.com**.

Test Battery Voltage

After initialization, the firmware enters the Test_

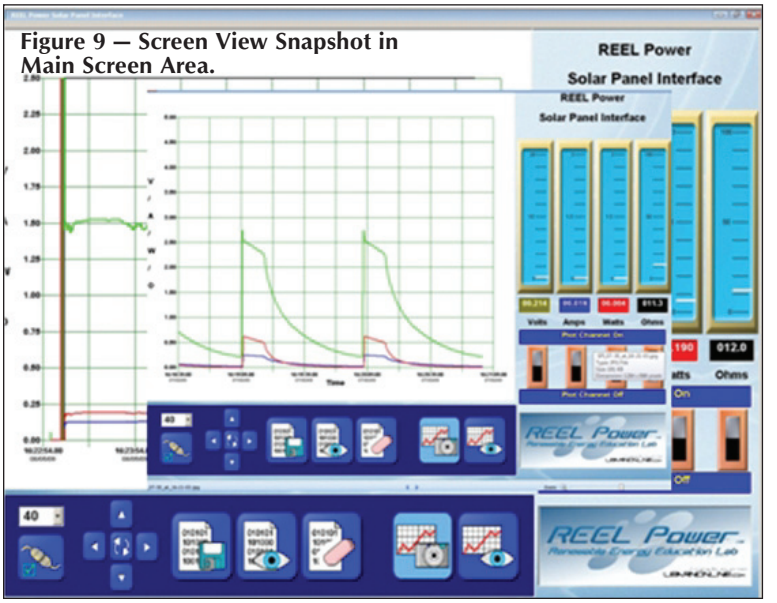


Figure 9 — Screen View Snapshot in Main Screen Area.

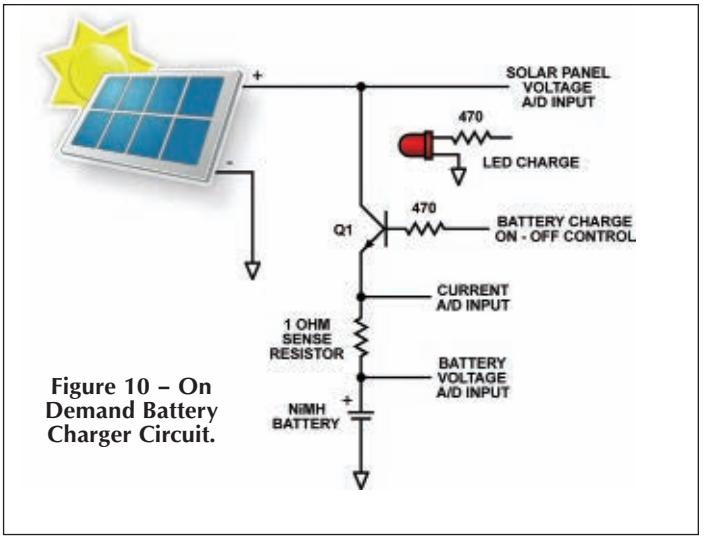


Figure 10 – On Demand Battery Charger Circuit.

Battery_Voltage loop where Q1 is turned OFF by setting its base resistor LOW. The LED is also extinguished. The routine does an A/D conversion of the battery voltage. If the voltage is above the full discharge voltage specified by the constant "fullDischargeVolts" in millivolts, nothing happens and the firmware loops back to the Test_Battery _Voltage label. If and when the battery voltage drops to, or below, the fullDischargeVolts level, the firmware branches to the Charge_Battery label.

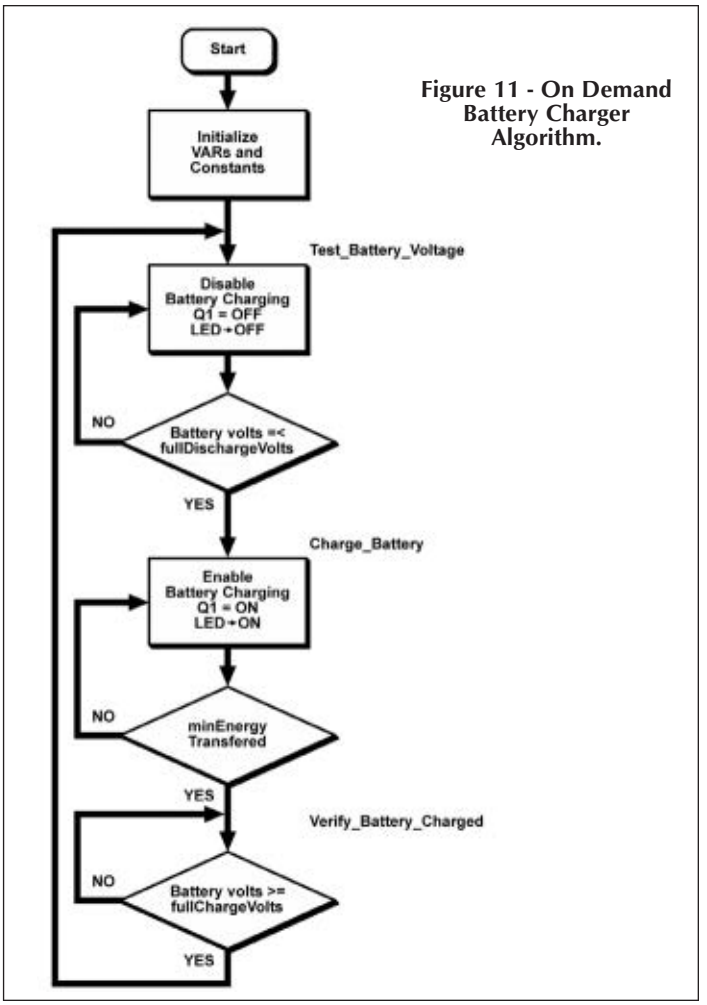


Figure 11 - On Demand Battery Charger Algorithm.

Charge_Battery

At this point, Q1 is turned ON and several things are set into motion. First, the LED is illuminated indicating charging is taking place. At the same time, an "energy loop" is initiated that guarantees a minimum amount of charge, C, going into the battery (and maybe also into the load if one is connected). The energy loop consists of a 60 second time sample coupled with measuring the current flow into the battery. With it, we want to charge the battery with at least 0.05C (1/20 C) before exiting the charge cycle.

For example, a constant called "minEnergy" is established in the first part of the code that represents 0.05C of the battery. For our test battery, this is 122.5 mAh (2,450 mAh x 0.05 = 122.5 mAh). You can adjust this to any level based on your particular battery's capacity and/or solar panel output. Because we are using a 60 second sampling loop, we need to convert mAh into mAm or milli-Amp-minutes. Since there are 60 minutes to an hour, we need to multiply the 0.05C value by 60. In our case, that would be 122.5 x 60 which makes our minEnergy value = 7,350 mAm. So, every 60 seconds the code will sample the current, add it to the previous current sample, and compare this value to minEnergy. Once the minEnergy value is achieved, the next part of the algorithm is engaged.

Verify_Battery_Charged

Next we look at the battery voltage at the Verify_Battery_Charged label. If it is at or above the fullChargeVolts, then we branch back to the Test_ Battery_Voltage label and the process starts all over again. However, if the battery is still below the fullChargeVolts level — maybe due to a heavy load draining it as it tries to charge — the firmware stays in the Charge_Battery loop (with Q1 ON) until the fullChargeVolts level is reached (if ever, depending on the load and the sunlight striking the solar panel). The LED flashes (toggle instruction) to let you know that we are in the Verify_Battery_Charged loop.

And that's it; that's our "on-demand" battery charging algorithm that should keep our NiMH battery active without ever reaching full charge or overcharging, but always with enough energy to do the job of powering our load. Of course, you can change any of the constants and variables to match what YOU want the charger to do, like apply a deeper charge or change the voltage trip points. Remember, this is your experiment. I'm only here to give you guidance.

The Middle Multiply Operator (*/)

Cell Equivalent Circuit

In all the firmware code in all the experiments, I convert A/D counts directly to millivolts and milliamps.

This is a great help in understanding what is really going on with the circuits under test and it aids in computing power and resistance, as well. To do this, probably the most overlooked, most misunderstood, and possibly most powerful operator in the entire Basic language repertoire is employed; that is, the middle multiply operator known by its "*/" symbol. What it does is impart floating point math to Basic.

If you've ever wanted to multiply a number or variable by an integer-fraction like 1.22 (i.e., a floating point number), this is the operator to use. While it's not a full-bodied floating point that will multiply your number to 10 digits after the decimal point, it will certainly get the job done in terms of what we need to do. And what we need to do is multiply a raw binary A/D count by the millivolts per count value that each bit represents. For example, our 12-bit A/D converter resolves each bit to 1.22 millivolts per count with a five volt reference (5,000 mv / 4096 = 1.22 mv/count). So, to convert raw A/D counts to millivolts, do the following:

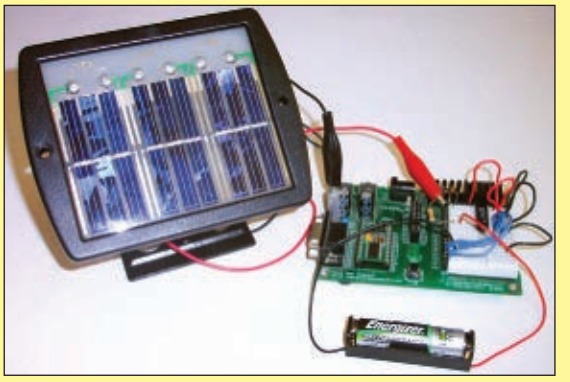
- First, separate the integer part (1) from the fractional part (.22).
- Take the fractional part and manually multiply by 256, as in 256 * .22 = 56.32.
- Round up the 56.32 to the closest integer (or 56, in this case).
- Convert 56 decimal to 38 hex.
- Convert the integer part to hex, as well as in 01 hex.
- Combine the two hex numbers into a 16-bit Word variable as in 0138 hex.
- Multiply the A/D count by 0138 hex as in 1000 */ $0138 = 1220 ($ ~ hex).
- The answer is now directly in millivolts.

Parallax does a great job in explaining this in their BASIC Stamp Manual, which is how I first discovered it and began to use it. Other Basics need to follow suit with clearer, more functional explanations (I won't mention any names). Do the same for our PICAXE 10-bit A/D converter that resolves each bit to 4.88 millivolts per count (5,000 mv / 1024 = 4.88 mv / count). Hint: The answer is $04E1. Proof left to student.

Summary

I've devoted this article to more on the background of battery technology and proper charging techniques than to pure alternative energy, but the two are closely linked since charging batteries this way obviously saves energy and doesn't create air pollution. Next time, we'll build a sun tracker-battery charger combination that will follow the sun all day instead of you needing to adjust the solar panel manually for maximum sunlight.

This is a cool experiment that I hope you will enjoy and, of course, it uses the BS2 and 28X2 micros as the main controllers. So, until next time, conserve energy and "stay green." **NV**



This is an example of the simple battery charger hookup using the Parallax BS2 inserted into the Board of Education. The three-module solar panel shown here and referred to in the parts list on the LearnOnLine website is used in all of the solar experiments. For its physical size, voltage and current capabilities, and series-parallel combinations, it is one of the most versatile solar panels I've come across in a long time.

Gizmos that bring your dreams to life!

DO YOU NEED A GIZMO?

Intel USB Web Camera
640x480 resolution
Composite video in
Focus distance 10cm-up
3 meter USB cable
$12.50 ea

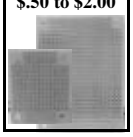
[This space intentionally left blank]

OR Scientific Smart Globes $25 each

Weather Stations from $35

Power Supplies
9V 1 Amp $4
12V 2 Amp $8.50
12V / 5V $15

Perf Boards $.50 to $2.00

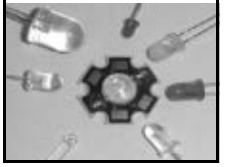


NIMH Battery Packs 8.4V 2000mAH $2.50

Project Boxes (Many Sizes) Starting at $1.50

Hobby Motors Starting at $2

1000's of LED in stock
1.8mm, 3mm, 5mm,
and 10mm from $.40
1/2 watt $.95
1 watt Stars $3.60
RGB 5mm$1.50
UV 5mm $.95



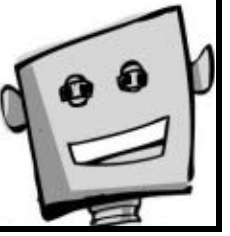
Dorkboard Kits Arduino compatible $6.25

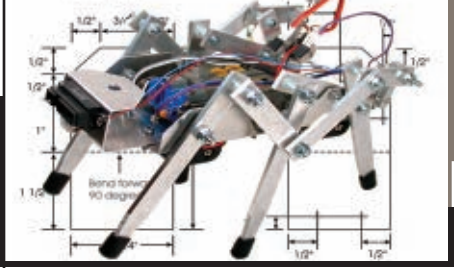
How About Soldering Supplies?

Variable Temp Solder Iron w/ 3 tips $29.95
6 piece Tweezer sets $5.00

(Want more? See our web store)

WWW.SurplusGizmos.com
503-439-1249
5797 NW Cornelius Pass Road
Hillsboro Oregon 97124
To see the best deals join our online mailing list or stop by our retail store...!





■ BY VERN GRANER

THE HALLOWEEN PROP DROPPER

After all these years dispensing treats, wouldn't it be fun to deliver a few tricks this year? The darkened porch is dimly lit by the glow of a single Jack-o-lantern. Riding a sugar buzz, the costumed trick-or-treaters swarm up the stairs and ring the bell. You open the door and they shout TRICK OR TREAT! You look at them gravely, then slowly raise your eyes to the ceiling above them. Puzzled, they look up just in time to see a big black bat come swooping down towards them! They shriek in surprise, then laugh and giggle when they see it's just a rubber bat that is now winding its way back up to the ceiling. You hand out candy and listen to the kids talk about how cool and scary that bat was and who they're gonna bring to see it. You smile slyly as you think to yourself "This is gonna be a fun night!" then push the door shut to await your next victims.

DROP WHAT YOU'RE DOING!

How fun would it be to drop a Spooky Spider, a Ghoulish Ghost, or a Scary Skeleton right out of "thin air" above unsuspecting trick or treaters? The Prop Dropper is a "quick and dirty" Halloween project you can probably put together in a single night with just a small microcontroller, a couple of servo motors, and a few bits and pieces from the ol' junk box. The Prop Dropper is designed to detect the presence of a person, rapid-deploy a small prop, display it for a moment, then wind it back up out of view, ready for its next victim!

■ FIGURE 1. If a spool is turned sideways, the wire or string on it tends to fall off the end.

WHERE THE HECK DO YOU GET THESE IDEAS!?

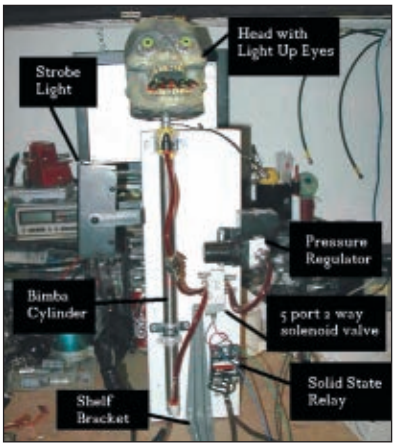
It's not uncommon for folks to ask where the inspiration for this type of project comes from. Sometimes it's just a matter of necessity guiding the development. Other times, it's simply an accident. The idea for this particular project was sparked when I was carrying a small spool of hookup wire. I shifted the spool from one hand to the other as I reached to open a door and the spool turned sideways, dumping a length of wire right off the spool to the floor (similar to the photo shown in **Figure 1**).

As I was grumbling and winding the wire back up, it occurred to me that it might be possible to make a purpose-built device that would do this very same "drop" effect. If there hadn't been a flange on the downward facing spool edge, it seemed likely that the entire spool would have emptied. Based on this observation, I guessed I could put together something that would use this method to quickly drop an item into view and then retrieve it.

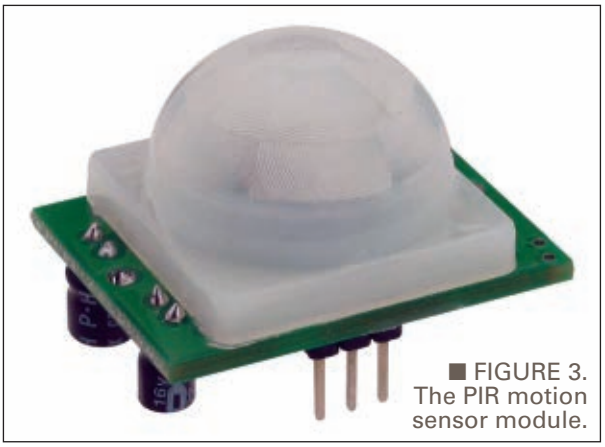
STOP, DROP, AND SCREAM!

As I've been involved in putting on various private and commercial haunted houses in the last decade (see Resources), I've seen lots of mechanisms used to pop an item into view. Most of them incorporate sophisticated designs using pneumatic systems or mechanical linkages (**Figure 2**). I wanted something that would perform a similar deploy/retrieve function, but I really wanted it to be simple in operation and easy to build.

After sketching a number of designs, I finally settled on using one continuous-rotation modified servo as a winch and one standard servo to position the winch servo. To drive them, I chose the EFX-TEK Prop-1 controller board that features our old friend the Parallax BASIC Stamp



■ FIGURE 2A and B. The Pop-Up Trash can is an example of a complex pneumatic prop deployment system.



■ FIGURE 3. The PIR motion sensor module.

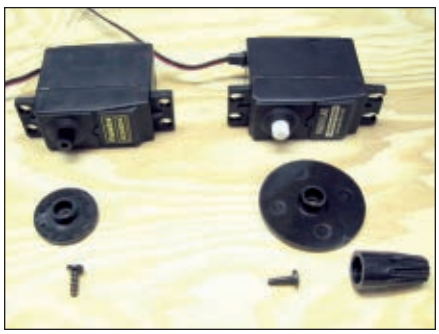
microcontroller. The Prop-1 control board was specifically designed to be used in commercial devices and has proven to be very robust. To allow the Prop Dropper to operate without requiring an operator, I used a low-cost PIR (passive infrared) motion detector as a trigger (**Figure 3**).

SCARE BY NUMBERS

In this month's article, I'll walk you through making the Prop Dropper step-by-step from hardware assembly through wiring, and then on to software and testing. First thing to do is get all the parts together (see Parts List). If you have a reasonably stocked junk box, you may be able to come up with everything you need just by digging around your workbench. If you don't have all the parts at hand, an entire kit of parts can now be ordered from the *Nuts & Volts* website (see resources for link). Either way, once you've gathered the parts, start with assembling the servos.

THE POSITION AND WINCH SERVOS

For the first step, get the winch servo, the position servo, the large round servo horn, the small round servo horn, and the wire nut together on your workbench (**Figure 4**). Begin by attaching the small round servo horn to the position servo (**Figure 5**). Manually rotate the servo horn so that the position servo is placed at approximately 90° (i.e., roughly centered). This is an important step, as you want to have the ability to move the winch servo to a straight-down position to deploy the prop, as well as a slightly up-canted position to allow you to wind the prop back up.

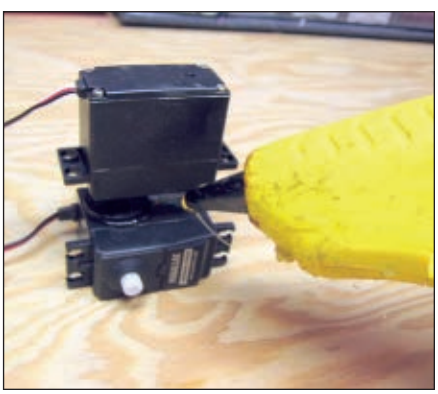


■ FIGURE 4. The position servo (left) and the winch servo (right) ready for assembly.

■ FIGURE 5. The position servo with small round horn attached.

Using a hot-melt glue gun, attach the small round servo to the body of the winch servo as shown in **Figure 6**. Next, mount the large round servo horn on the winch servo as shown in **Figure 7**. As the winch servo has no "stop" points, you do not need to take any precautions on pre-positioning the horn before you screw it down. Next, use a few drops of hot-melt glue to attach the wire nut to the center of the large round servo horn as shown in **Figure 8**. Once the glue has set, you should have a nice positionable winch assembly!

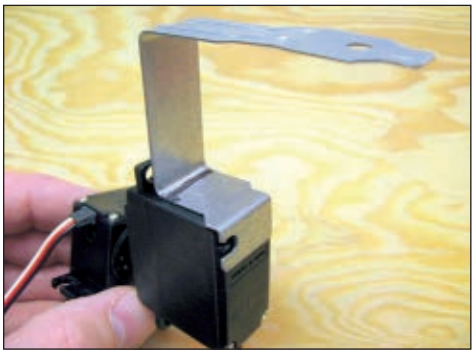
■ FIGURE 6. Hotmelt glue the position servo to the winch servo.



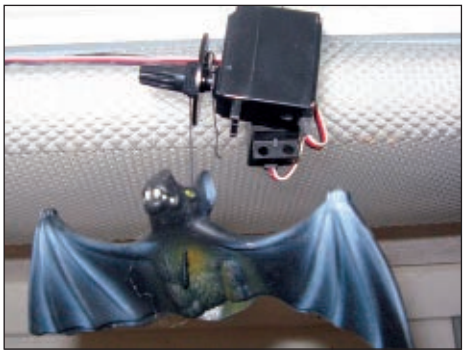
■ FIGURE 7. Winch servo with the large round servo horn in place.

■ FIGURE 8. Winch servo with wire nut glued to the center of the large round horn.

■ FIGURE 9. Drilling a hole where the string to the prop can be attached.



■ FIGURE 10. A temporary bracket created from an old PC card back plane, glued to the position servo.



■ FIGURE 11. The Prop Dropper in place with a prop wound up and ready to drop.

At this point, you need to drill a hole in the large round servo horn to allow you to attach the string that connects to the prop (**Figure 9**). For testing, I fabricated a temporary hanging bracket using an old PC back plate that I glued to the back of the position servo (**Figure 10**). I then attached a small rubber bat to the large round servo horn and hung the completed assembly from the ceiling in my shop for testing (**Figure 11**). A video of the Prop Dropper in action is available online (see resources).

WIRE IT UP

Strangely for an electronics project, the wiring for this device is one of the simplest steps! The EFX-TEK Prop-1 controller makes it a literal matter of plug-and-play — there is no soldering involved in assembling this entire project. To illustrate, the schematic is shown in **Figure 12** and a photo of how the servos and motion sensor are attached is shown in **Figure 13**. (Note: This simple assembly process makes the Prop Dropper an ideal project to share with youngsters!)

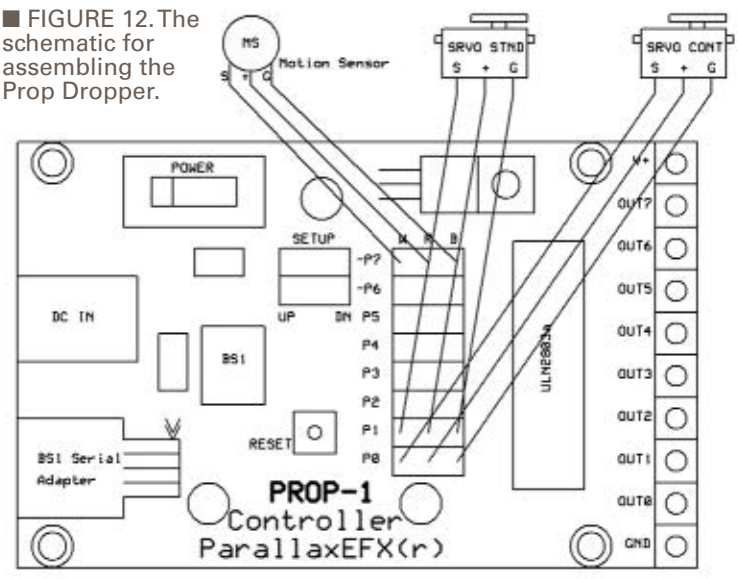
Following the schematic, plug the winch servo into the P0 header, the position servo into P1, and the motion detector into P7. When connecting the servos and the motion detector, be sure to watch the polarity of the plugs to make sure the white lead is connected to the "W" pin of the jack. The pins are clearly labeled at the top of the Prop-1 with W, R, and B to help guide you.

DROPPER CODE

Now that we're all wired up, it's time to get familiar with the software. The basic software used to operate the Prop Dropper consists of a single loop with one decision point in it. The flow chart is shown in **Figure 14**. Following the flowchart, you can see we begin by waiting in a loop for the input to be triggered. Once a trigger has been detected, we send pulses to the position servo that causes it to move the winch servo to its "pointing down" mode. This causes the string to fall off the end of the wire nut and allows the prop to drop.

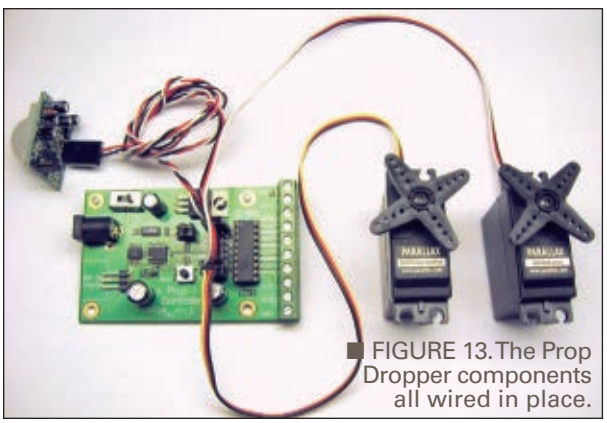
Next, we wait a bit while the prop dangles in the air, then send pulses to the position servo to position the winch servo pointing up to the retrieve angle. Once the retrieve angle has been reached, we send pulses to the winch servo to cause it to wind the string back up. The amount of time the winch servo runs is based on the length of the string, i.e., longer string = more wind time. Once the winch servo has retrieved the prop, we then pause for a bit to keep the prop from being prematurely re-triggered immediately after deployment.

■ FIGURE 12. The schematic for assembling the Prop Dropper.



DOWNLOADING AND TESTING

You can download the source code for this



■ FIGURE 13. The Prop Dropper components all wired in place.

project from the *Nuts & Volts* website (see resources for link). Once you have the code downloaded, you will need to configure some of the values to match your specific construction. First, you will need to discover the value that causes your winch servo to stop moving. Typically, this is when the pulses sent are at 1.5 ms or center position for the servo. In the source code, this is the line where you set the pulse width value:

```
SYMBOL Hold = 150 ' Value to cause Winch Servo
to stop moving
```

If the continuous-rotation servo motor doesn't halt with the default value of 150, you can either choose to change the 150 value slightly to accommodate your specific winch servo or insert a small screwdriver into the small hole in the side of the servo to adjust the servo's stop point.

The next value to look at is the one that controls the winch servo's position. This is the line:

```
SYMBOL Drop = 200 ' Value to move Position Servo
to"drop" position
```

You need to change this value until the winch servo is moved to the drop position. On my test setup, a value of 200 was about right. The last value to deal with is the position of the winch servo when it is winding in the string. The line to look for is here:

```
SYMBOL Retrieve = 120 ' Value to move Position
Servo to "hoist" position
```

Again, with my test system here, a value of 120 placed the winch servo with a slight upward angle that kept the string snug against the large servo horn. The optimum angle for your rig might be different depending on the type of string you're using, the position at which you are mounting the device, the weight of the prop, and other variables. The best idea is to test it with varying values until you get a consistent reeling of the prop.

The last value you will need to adjust is the amount of time the winch servo spends winding up the string. This is done by varying the value in the line here:

```
FOR cntI=1 TO 640 'Adjust for hoist time (i.e.
higher value=longer string)
```

The value of 640 causes my version to run the hoist for approximately 10 seconds. You will need to vary this so the winch runs the appropriate amount of time for the length of the string on your prop and the diameter of the wire nut you use.

In addition to the above values, you can also change the "hold off" value to adjust how long the prop waits between allowed activations. On my rig, I set the value to 12 seconds to allow people to clear out from under the prop before the motion sensor started looking for motion again. The line of source code you need to adjust is shown here:

```
PAUSE 12000 ' hold off a bit before we trigger
again
```

Once you've made the changes above, download the source code into the Prop-1 and test the values until you get it dialed in.

RESOURCES

The Prop Dropper Video
www.youtube.com/VernGraner

The Spider's PreyGround Haunt
Main Page:
www.spiderspreyground.com
Video from 2004:
www.youtube.com/watch?v=ICf6EjPZtNI
Video from 2005:
www.youtube.com/watch?v=xoku6LpYxd4

Complete Kit of Prop Dropper Parts at the *Nuts & Volts* Store
store.nutsvolts.com

Prop Dropper Source Code
www.nutsvolts.com/index.php?/magazine/downloads

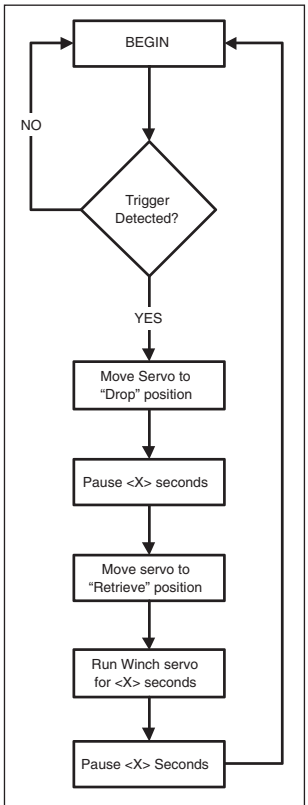
CR P300-120 Audio Board
http://store.nutsvolts.com/product.php?productid=16885&cat=0&page=1

EFX-TEK Professional Prop Electronics
Main Page: **www.efx-tek.com**
Promo Video:
www.youtube.com/watch?v=7ncaX9QNSrI

PROJECT CASE IDEAS

Depending on your intended mount point, it is possible to operate the Prop Dropper "uncased" as I did when testing (Figure 11). However, I found that a small plastic bucket made a very good case for the unit while also providing a place to hide the prop before it is deployed. Check out **Figure 15**. If the bucket is painted black, it will likely disappear into the darkness. I added a length of wire to allow me to hang the bucket from a single attachment point and drilled a hole in the center of the bucket to allow an exit point for both the DC power supply wire and the motion sensor lead (**Figure 16**).

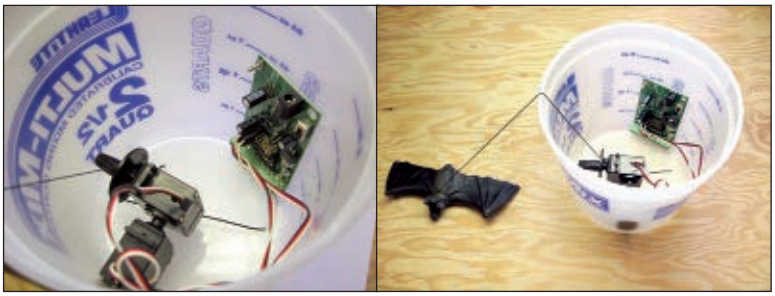
I found it best to attach the motion sensor to a point adjacent to the bucket (not directly on it). I did this for two reasons: first, to make sure that the sensor wouldn't be affected by the swinging of the bucket when the prop deploys; and second, to allow me to aim the motion sensor at a specific location. I also added an (optional) RCA female jack with two wires that I can attach to the P7 trigger input. This allows me to test-deploy the Prop Dropper with an external input like a simple pushbutton.



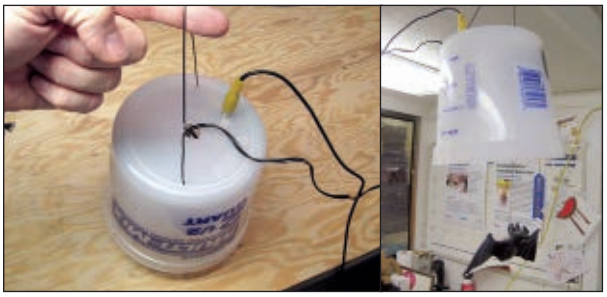
■ FIGURE 14. Software flow chart.

OPTIONAL PILL BOTTLE BUTTON TRIGGER

Though I love the effect of having the unit drop when



■ FIGURE 15 A and B. Prop Dropper servos and Prop-1 board mounted in plastic bucket.



■ FIGURE 16 A and B. Prop Dropper bucket with power lead and suspension wire.

it detects motion (I've even managed to startle myself!), I wanted to experiment with other methods of triggering. If you're wanting to have pin-point control of when things drop, you can use this simple pill bottle button trigger (**Figure 17**). I found that palm-sized prescription drug bottles with child proof caps make for very good enclosures for a home-brew handheld trigger. The device is created by drilling a hole in the bottom of the pill bottle (**Figure 18**) and mounting a small pushbutton switch. Though pretty much any pushbutton momentary switch will do, I used a RadioShack CAT #275-1571 model switch (**Figure 19**). Next, drill a hole in the cap and mount a female RCA jack (**Figure 20**). By using a female RCA jack on the button and also on the Prop Dropper itself, it's easy to get the right length of cable by simply using any male to male RCA cable you happen to have lying around (**Figure 21**).

VARIATIONS ON A THEME

At this point, you should have a fully operational Prop Dropper to use for Halloween. However, I want to point out that this little design has quite a bit of hack potential. In the course of developing this device, I came up with a bunch of improvements and modifications, some of which I've already built and tested. As a way to excite your imagination, I've compiled a list of the various ideas I had on how you can alter, update, and re-use the Prop Dropper design:

Use a Different Prop — Though all my examples above show the Prop Dropper being used to drop a Halloween scare, the Prop Dropper could just as easily be used to drop snowflakes, Christmas ornaments, a sprig of mistletoe (that should get you thinking!), Easter eggs, or even a Birthday card. You don't have to limit the Prop Dropper to the Halloween decorations bin as you can surprise your guests or family with any seasonal or occasional item that the servo motor can hoist. In fact, you could reduce the design to a single servo that held a small paper cup. Fill the cup with confetti and you could have a synchronized confetti drop for a party!

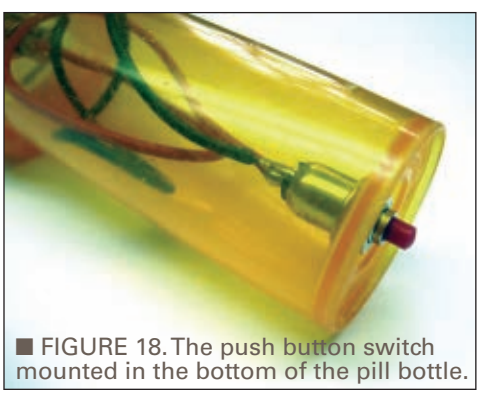
Smaller or Stronger — The first Prop Dropper I constructed used standard servos only because they were what I had handy. It is quite possible to build a much smaller or even much larger Prop Dropper using some of the more powerful or more compact servo motors available on the market.

More Droppers = More Fun! — The EFX-TEK Prop-1 can accommodate up to six servo motors along with a motion sensor and still have one I/O pin left over! It is possible to connect six servos and have the software trigger a sequence of drops down a hallway.

Sound Effects — Since the Prop-1 board uses a Parallax BASIC Stamp 1 chip, it is capable of using the SOUND command to create noise. It's possible to add some lines of code to create a siren-like sound or a loud chirp to help draw attention to the prop when it drops.

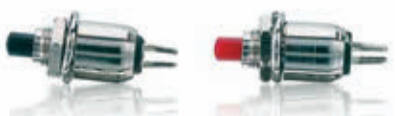
Pull Up or Sideways! — Using some pulley, or even a couple of cup-hooks, you can place the Prop Dropper on the floor and have it drop "up." This may allow you to drop something from a space that normally wouldn't accommodate the entire mechanism overhead, or allow you to place a scare without the bulk of the Prop Dropper overhead to give it away. Also, consider that if you need the deployment to be soundless, you could move the Prop Dropper to another location and just

■ FIGURE 17. Pill bottle pushbutton trigger.



■ FIGURE 18. The push button switch mounted in the bottom of the pill bottle.

■ FIGURE 19. RadioShack CAT #275-1571 pushbutton switches.



run the line to where it's located.

Synchronized Sound Effects! — You can add a serially controlled sound effect unit such as the CAR P300 Audio Board kit from the *Nuts & Volts* store. This will allow you to trigger just the right sound when your prop drops! Make a scary synchronized scream, play a Happy Birthday tune, play the graduation march, or launch into a Christmas carol to accompany just about any surprise reveal.

■ FIGURE 20. The pill bottle pushbutton switch ready for assembly.

■ FIGURE 21. Female RCA jack mounted on the pill bottle cap ready for connection.

Add a Limit Switch — Rather than using the timed retrieve method, it's possible to place a marker or device to indicate that the prop has been completely retrieved. One implementation would be to use a lever switch and a bead on the string. Cut a hole in a Popsicle stick, then run the drop line through the stick. Write a process that continues to loop waiting for the switch closure before it stops winding up the prop. This would allow different string lengths without having to re-program the chip with new winch time values. It would also allow a consistent retrieve distance even if the string stretched a bit with use.

Add a Variable Time Control — By adding a small potentiometer and using the POT command in PBASIC, you should be able to adjust one of the values of the device on-the-fly. For example, you could adjust the amount of time for the hold off or the length of time the prop is left dropped before it's wound back up. By changing some of the hard-coded values to POT created values, you could adjust for line length without having to build a limit switch or adjust how far you prefer the prop to retract after use.

Use RANDOM to Create Variety — Use the RANDOM function to have the Prop Dropper dispense a different surprise on each trigger or to have it set a random hold off value. The random function can be used in various ways to alter the device's deployment to make it less predictable, especially if you're using the motion sensor to activate your Prop Dropper.

IN CLOSING

As you can see, with a little imagination the Prop Dropper can become a very fun and useful little gadget to have around. I hope you build one and use it. If you do, please write and let me know how it went. I can be reached at vern@txis.com. **NV**

PARTS LIST FOR THE PROP DROPPER

QTY	DESCRIPTION	MANUFACTURER
1	Prop-1 Controller Board	EFX-TEK 31101 or equiv
1	PIR Motion Sensor	EFX-TEK 555-28027 or equiv
1	4" Extension Cable	EFX-TEK 805-00035 or equiv
1	Continuous-Motion Servo	Parallax 900-00008 or equiv
1	Futaba 3004 Standard Servo	SparkFun ROB-09064 or equiv
1	Wirenut	Home Depot 30-072 or equiv
1	Prop to drop	Oriental Trading IN-25/1258

The Prop Dropper now in KIT FORM!

Due to some fancy footwork from the folks at EFX-TEK and the good folks over at the *Nuts & Volts* Store, you can get a complete kit of parts to make your very own Prop Dropper. This is great if your junk box is a little light on parts or if you don't have the time to scrounge around for stuff. The Prop Dropper kit includes both a continuous-rotation and a standard servo, as well as the Prop-1 unit from EFX-TEK. All you need to do is spend a bit of time assembling it with a hotmelt glue gun and you should be ready to go! The Prop Dropper kit is a fantastic foundation for more experimentation in special effects.

A kit can be purchased online from the *Nuts & Volts* Webstore **www.nutsvolts.com** or call our order desk at **800-783-4624**.

Build Your Own:

THEREMIN

Theremax
The Ultimate Theremin

PAiA
paia.com
Electronic Music Kits and More

Music/Tutorials/Kits
Analog Synthesizers
Guitar Effects
Tube Electronics
Studio Gear

AP CIRCUITS
PCB Fabrication Since 1984

As low as...
$9.95 each!

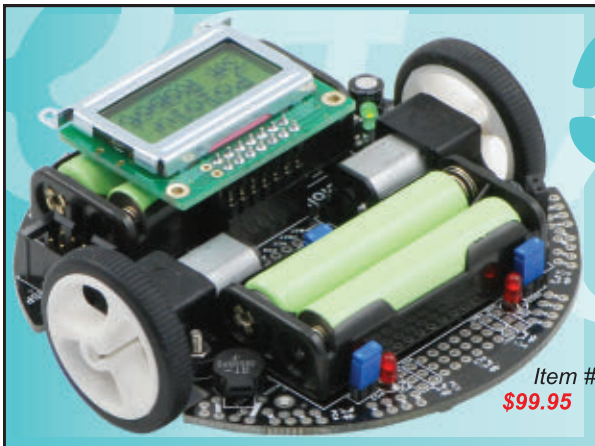
Two Boards
Two Layers
Two Masks
One Legend

Unmasked boards ship next day!

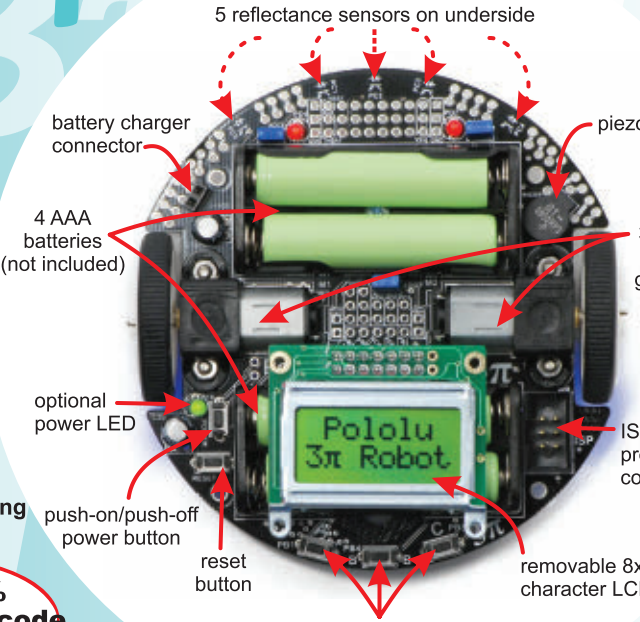
www.apcircuits.com

VISA MasterCard PayPal IPC MEMBER ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES BBB

3pi Robot



Item #975
$99.95



The Pololu 3pi robot is a high-performance, compact mobile platform featuring:

* Two metal gearmotors
* Five reflectance sensors
* 8×2 character LCD
* Three user pushbuttons
* Buzzer and LEDs
* High-traction silicone tires
* Speeds exceeding 3 ft/sec using innovative constant-voltage motor supply

All peripherals are connected to an ATmega328P microcontroller running at 20 MHz, with free C-programming tools, libraries, and support for the Arduino environment.

Pololu
Robotics & Electronics
6000 S. Eastern Ave. 12D, Las Vegas, NV 89119

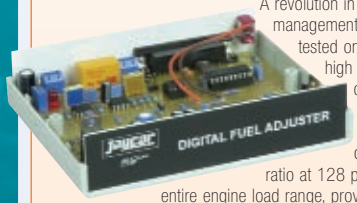
Save 10%
With coupon code
NV3PI44

Find out more at www.pololu.com/3pi or by calling 1-877-7-POLOLU.

AUTOMOTIVE KITS FOR ELECTRONIC ENTHUSIASTS

DIGITAL FUEL ADJUSTER

KC-5385 $49.50 plus postage & packing



A revolution in budget engine management. Extensively tested on a wide range of high performance cars, this unit gives you complete control of the air/fuel ratio at 128 points across the entire engine load range, providing incredible mapping resolution and brilliant drivability. Supports both static and real-time mapping. Kit supplied with a quality solder masked PCB with overlay, machined case with processed panels, programmed micro and all electronic components.

Requires Handheld Digital Controller KC-5386 (below) - no need for a laptop!

DIGITAL TACHOMETER

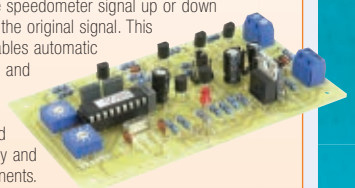
KC-5290 $39.50 plus postage & packing

A clear 4-digit LED tachometer showing up to 9,900rpm in 100rpm increments. Housed neatly in a small jiffy box (83 x 54 x 31mm) to mount nicely on your dashboard, it features 10 LED bargraph with optional dot or bar mode (showing 8-independent rpm thresholds), calibration options for 1- 12 cylinder 4-stroke or 1- 6 cylinder 2-stroke engines, anti-flickering and automatic night-time display dimming. This kit can also be combined with our rev limiter KC-5265, to perform engine limiting. Kit includes case with silk-screened panel, PCBs, pre-programmed PIC micro, 7-segment displays, red acrylic, hook-up wire and all electronic components.

SPEEDO CORRECTOR MKII

KC-5435 $32.00 plus postage & packing

Modifying your gearbox, diff ratio or changing to a larger circumference tyre may result in an inaccurate speedometer. This kit readjusts the speedometer signal up or down from 0% to 99% of the original signal. This upgraded model enables automatic input setup selection and indicates when the input signal is being received. Kit supplied with PCB with overlay and all electronic components.



Recommended box UB5 use HB-6013 $2.00

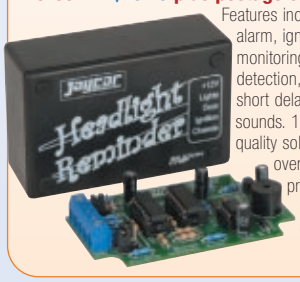
HANDHELD DIGITAL CONTROLLER

KC-5386 $39.50 plus postage & packing

Used for the mapping/programming of the digital fuel adjuster kit (above), it features a two line LCD and easy to use push buttons. Both an interface and display - use it to program the adjuster or leave it permanently connected to display the adjuster's operation. Kit supplied with silkscreened and machined case, PCB, LCD, and all electronic components.

CAR HEADLIGHT REMINDER

KC-5317 $16.25 plus postage & packing



Features include a modulated alarm, ignition and lights monitoring, optional door switch detection, time-out alarm and a short delay before the alarm sounds. 12VDC kit includes quality solder masked PCB with overlay, case with screen printed lid and all electronic components.

HIGH PERFORMANCE TIMER

KC-5379 $25.00 plus postage & packing

A sophisticated timer adaptable for two types of uses. The first is 'one shot' operation, which can be used to keep electric windows active, or a thermo fan running for a period after ignition is switched off etc. The second is a 'pulse' type operation, which can be used to squirt water spray for 1 second every 9 seconds. The uses are endless, with time adjustable from 0.1 sec to 16.5 mins. Kit supplied with PCB and all electronic components.

CAR BATTERY MONITOR

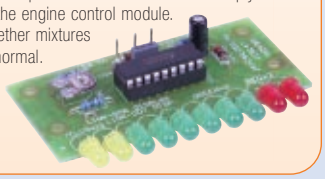
KA-1683 $10.50 plus postage & packing

Don't get caught with a flat battery! This simple electronic voltmeter indicates the condition of your car's battery so you can act in advance and avoid getting stranded. Kit includes PC board and all components.

MIXTURE DISPLAY FOR FUEL INJECTED CARS

KC-5195 $10.00 plus postage & packing

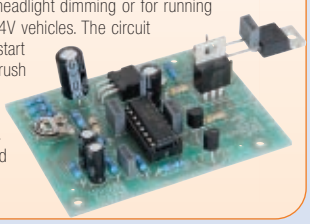
Also known as an EGO (exhaust, gas, oxygen) monitor, this simple kit allows you to monitor your car's fuel mixtures. Use it as a tuning tool to help in vehicle modification or simply to see the behaviour of the engine control module. LEDs indicate whether mixtures are rich, lean or normal. PCB, LEDs and components supplied. Thousands sold!



10A 12VDC MOTOR SPEED CONTROLLER

KC-5225 $14.50 plus postage & packing

Ideal for controlling 12VDC motors in cars such as fuel injection pumps, water/air intercoolers and water injection systems. Use it for headlight dimming or for running 12VDC motors in 24V vehicles. The circuit incorporates a soft start feature to reduce inrush currents, especially on 12V incandescent lamps. Kit includes PCB and all electronic components.



FREE CATALOG

Checkout Jaycar's extensive range

We have kits & electronic projects for use in:

- Audio & Video
- Car & Automotive
- Computer
- Lighting
- Power
- Test & Meters
- Learning & Educational
- General Electronics Projects
- Gifts, Gadgets & Just for fun!

For your FREE catalog logon to www.jaycar.com/catalog

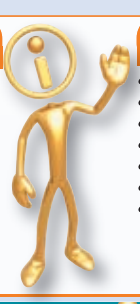
or check out the range at www.jaycar.com

POST & PACKING CHARGES

Order Value	Cost
$25 - $49.99	$7.50
$50 - $99.99	$20
$100 - $199.99	$40
$200 - $499.99	$60
$500+	$75

Max weight 12lb (5kg).
Heavier parcels POA.
Minimum order $25.

Note: Products are despatched from Australia, so local customs duty & taxes may apply.
Prices valid till 31/10/09



HOW TO ORDER

- ORDER ON-LINE: www.jaycar.com
- PHONE: 1-800-784-0263
- FAX: +61 2 8832 3118*
- EMAIL: techstore@jaycar.com
- POST: P.O. Box 107, Rydalmere NSW 2116 Australia
- ALL PRICING IN US DOLLARS
- MINIMUM ORDER ONLY $25

*Australian Eastern Standard Time (Monday - Friday 09.00 to 17.30 GMT + 10 hours only)
Expect 10-14 days for air parcel delivery

■ BY FRED EADY

UNCLOAKING A 16-BIT USB FRONT END FOR THE ENC624J600

If you had the opportunity to attend the 2009 Microchip MASTERS TCP/IP class I hosted this year in Scottsdale, AZ you got a sneak peek at a couple of (then) future Design Cycle hardware designs. You also had a chance at winning a copy of *Nuts & Volts Magazine* containing a Design Cycle column that augmented the TCP/IP class or an assembled and tested EDTP Ethernet MINI.

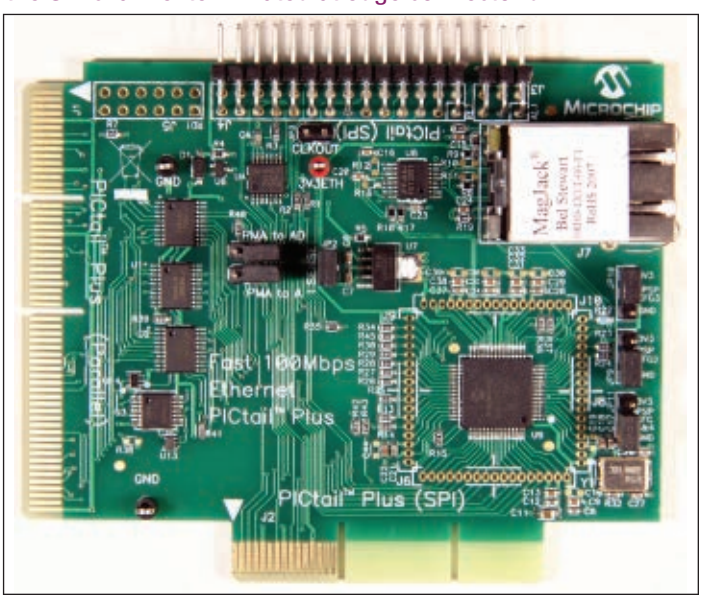
The first of the MASTERS sneak-peek Design Cycle columns appeared last month. We completed the conversion of an EDTP Ethernet MINI from a legacy RS-232 to a USB interface that was also configured to power the Ethernet MINI. This month, we'll uncloak the second design: a 16-bit USB front end for the newly announced Microchip ENC624J600 Stand-Alone 10/100 Ethernet Controller.

THE MOTHERSHIP CONNECTION

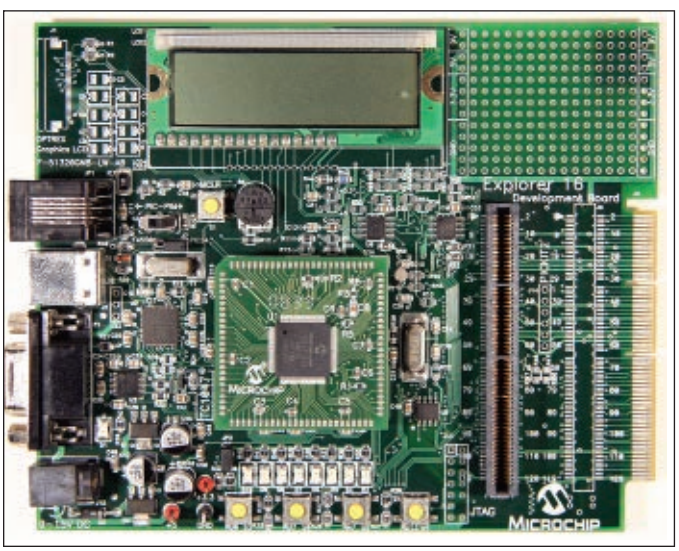
My first inclination was to design and build this application on a custom printed circuit board (PCB). However, to take that route would limit our ability to experiment freely with the SPI and parallel port interfaces offered by the ENC624J600. So, rather than commit to an application-specific PCB at this time, I decided to go with the current set of off-the-shelf Microchip development tools that are specifically aimed at the ENC624J600. With that, we'll be working with the Microchip Fast 100 Mbps Ethernet PICtail Plus daughter board you see in **Photo 1**.

The backbone of this month's project hardware is a Microchip Explorer 16 development board like the one lying under the lights in **Photo 2**. In addition to supporting the Microchip family of 16-bit and 32-bit microcontrollers, the Explorer 16 development board's resources can be complimented with various PICtail plug-in boards. The Explorer 16 displayed in Photo 2 has a 100-pin PIC mounted via a 100-pin PIM (plug-in module). The

■ PHOTO 1. The Fast 100 Mbps Ethernet PICtail Plus Daughter Board offers parallel and SPI paths to the ENC624J600 which is mounted to the lower right. Our discussion will focus on the SPI channel terminated at edge connector J2.



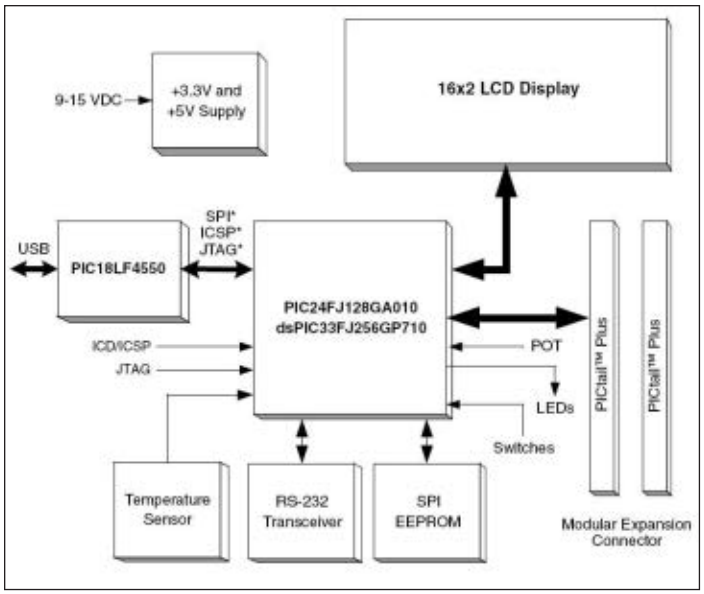
■ PHOTO 2. The Microchip Explorer 16 Development Board is a multi-purpose development platform. The Explorer 16 can accommodate differing 16-bit and 32-bit PIC devices by simply mounting a PIM (Plug-In Module) which hosts the desired microcontroller device.



Explorer 16 will also accept 16-bit 44-pin devices like the PIC24FJ64GA004. The smaller pin count parts are adapted to interface with the same 100-pin PIM used by the larger 100-pin parts.

As you can see in **Figure 1**, the Explorer 16 board is made up of an on-board USB interface based on the PIC18LF4550, a legacy RS-232 port, a Microchip ICSP programming/debugging portal, and a 16 x 2 LCD. The 100-pin Explorer 16 bundle comes standard with a PIC24FJ128GA010 PIM. If you're interested in working with the lower pin count 16-bit PICs, you can also get a development board bundle that includes a PIC24FJ64GA004 PIM.

Our design will replace the standard equipment PIC24FJ128GA010 PIM with a PIC24FJ256GB110 PIM, which is the 16-bit USB-capable variant. The PIC24FJ256GB110 also contains twice as much program memory as the PIC24FJ128GA010. We may need the additional program memory as we'll be working with and loading firmware based on both the Microchip TCP/IP Stack and the Microchip USB Framework.



■ FIGURE 1. Since we're replacing the PIC24FJ128GA010 with a PIC24FJ256GB110, we won't require the services of the Explorer 16 Development Board's PIC18LF4550. Our design will also relieve the SPI EEPROM that is standing watch on the Explorer 16.

FUEL FOR THE ELECTRON ENGINE

The ENC624J600 has all of the tools it needs to operate on an Ethernet LAN. However, the ENC624J600 does not contain a program memory area, data memory area, or the CPU necessary to execute instructions that make up an application. So, we must pair it up with a suitable microcontroller to be able to utilize the facilities of the TCP/IP stack and MCHPFSUSB Framework.

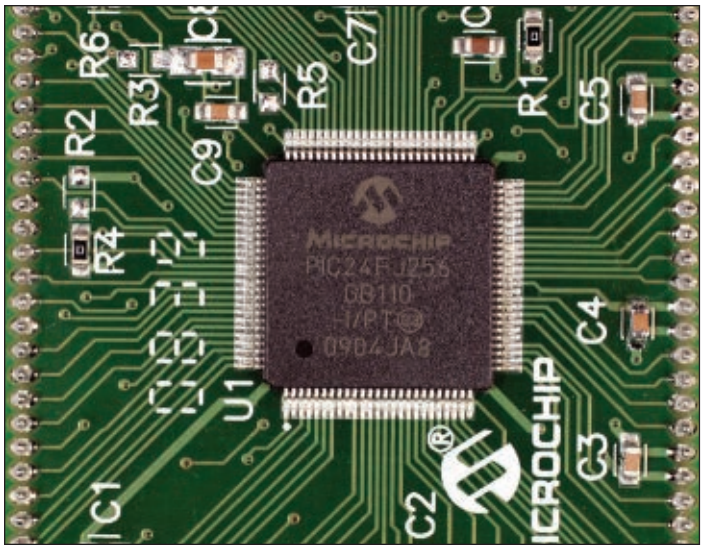
The PIC24FJ256GB110 in **Photo 3** is a formidable microcontroller that sits on a 16-bit Modified Harvard Architecture frame. Modified Harvard Architecture allows program instructions and data to reside in the same memory area. Thus, initial data values programmed into the program memory area can be copied from program memory to data memory once instruction execution begins. Some PICs also allow data memory to be written to program memory under program control. If the data that is placed into program memory is application constant data, the constant data need not be moved to data memory to be accessed by the CPU. So, Modified Harvard Architecture is really a combination of specialized machine language instructions coupled with a hardware pathway that allows program memory locations to emulate data memory locations.

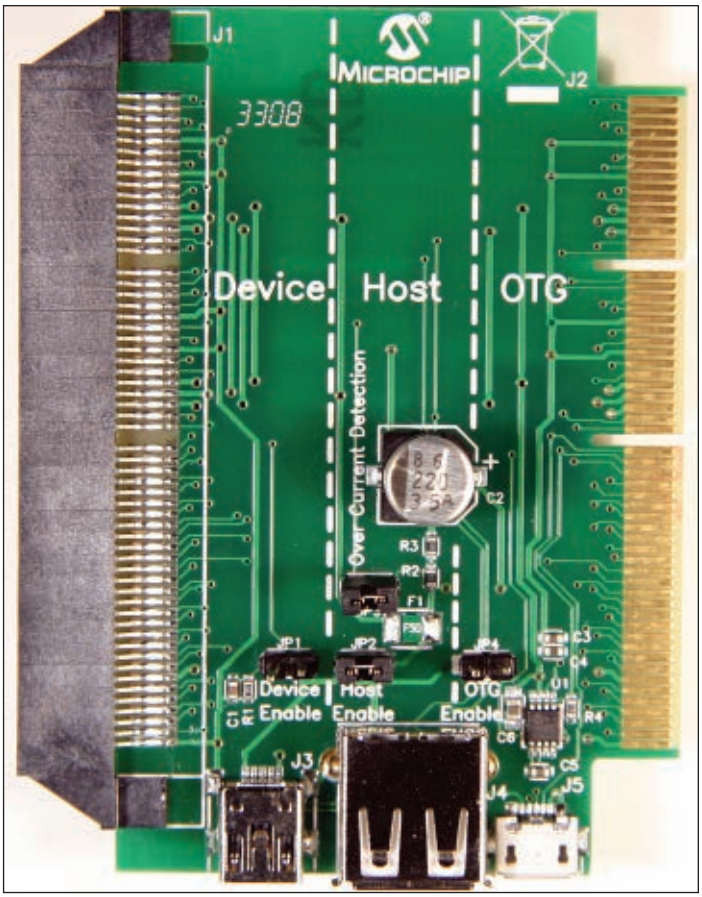
The PIC24FJ256GB110 has a large number of peripherals. In fact, it has more peripherals than can be mapped into its 100 pins. Every application should never need all of the peripherals and every application doesn't need the same peripherals. So, this PIC has the ability to assign its pool of peripherals to a fixed set of remappable I/O pins under program control. This feature is officially called peripheral pin select. The PIC24FJ256GB110 has 44 pins available for peripheral pin select operations.

On the USB side, the PIC24FJ256GB110 is USB v2.0 On-The-Go (OTG) compliant, which means that it's a dual-role USB device and can be configured as a USB host or USB peripheral. In this project, we'll use the peripheral configuration and run the PIC24FJ256GB110 in USB full-speed device mode. Everything we need USB is contained within the PIC24FJ256GB110 silicon including a USB transceiver, USB engine voltage regulators, USB pull-up resistors, and the 48 MHz USB clock.

The plan is to use the PIC's USB interface as a replacement for a legacy RS-232 portal. This will allow us to pass data to and from the attached Ethernet LAN via the USB interface. The native USB interface found on the Explorer 16 development board only supports the on-board PIC18F4550. So, we'll need to add a USB PICtail

■ PHOTO 3. This is an up-close look at the PIC24F256GB110 that gives the Explorer 16 Development Board the microcontroller resources we need for our USB-to-Ethernet application.





■ PHOTO 4. Note that the USB PICtail Plus Daughter Board is partitioned to support USB Device mode, USB Host mode, and OTG. We will mount a shorting block across the Device Enable jumper (JP1) and operate on the USB signals present at mini connector J3.

Plus Daughter Board to the development board to gain access to the PIC24FJ256GB110's USB subsystem. The USB PICtail Plus Daughter Board is grinning at us in **Photo 4**.

HOUSTON, WE HAVE A PROBLEM

The TCP/IP stack templates default to the use of the #1 SPI channel on the PIC24FJ128GA010 to communicate with the ENC624J600. So, one would think that the easy thing to do in our case would be to simply use the #1 SPI channel on the PIC24FJ256GB110 in the same manner. Take a look at **Figure 2**. The PIC24FJ128GA010's #1 SPI channel pins SDO1, SDI1, and SCK1 are neatly arranged back-to-back. Now move your attention to **Figure 3**. Pin 53 of the PIC24FJ256GB110 represented in Figure 3 is a remappable I/O pin instead of the permanently assigned #1 SPI channel's SDO pin found on the PIC24FJ128GA010 in Figure 2. Figure 3's graphic also tells us that the rest of the PIC24FJ128GA010 #1 SPI channel pins in Figure 2 have been reassigned to USB duty on the PIC24FJ256GB110. What this all means is that we can't use the TCP/IP stack template's default to the #1 SPI channel with a PIC24FJ256GB110 microcontroller in charge. The PIC24FJ256GB110's USB I/O subsystem and a remappable I/O pin occupy the pins that the PIC24FJ128GA010 reserves for its #1 SPI channel. (Uhoh!)

Fortunately, the fix is an easy one. The PIC24FJ256GB110 has three SPI channels. We will use the PIC24FJ256GB110's #2 SPI channel instead. To do this, we simply plug the Fast 100 Mbps Ethernet PICtail Plus Daughter Board into the Explorer 16 as shown in **Photo 5**. Note that the Explorer 16 Development Board and Fast 100Mbps Ethernet PICtail Plus Daughter Board triangular Pin 1 markers don't match up. The Fast 100Mbps Ethernet PICtail Plus Daughter Board is plugged in to align its SPI channel interface with the Explorer 16 Development Board's #2 SPI channel interface. **Figure 4** is a representation of the USB PICtail Plus Daughter Board's view of the PIC24FJ256GB110's I/O subsystem. Note that we are not using pins 1 through 30 which hold the #1 SPI channel I/O pins. The Daughter Board is plugged in with its SPI channel aligned with the #2 SPI channel interface on pins 33 through 62.

Embedded electronics is akin to solving an algebra problem. What happens on one side of the equation must be offset by actions on the other side. In our case, the hardware side has been adjusted to accommodate the differing SPI channel pinouts with the offset plugging of the Daughter Board. We also have to do a bit of twiddling on the software side.

The first order of software business is to tell the application that we are using the PIC24FJ256GB110's #2 SPI channel to drive the Plus Daughter Board. This is easily done in the *HardwareProfile.h* file. All we have to do is

PIC24FJXXGA010
PIC24FJXXXGA010

63	OSC1/CLKI/RC1
62	VDD
61	TDO/RA5
60	TDI/RA4
59	SDA2/RA3
58	SCL2/RA2
57	SCL1/RG2
56	SDA1/RG3
55	SCK1/INT0/RF6
54	SDI1/RF7
53	SDO1/RF8

■ FIGURE 2. The #1 SPI channel is the default SPI communications channel in the TCP/IP stack templates. The PIC24FJ128GA010 is equipped with a pair of SPI channels while the PIC24FJ256GB110 has three available SPI channels. Note the permanent #1 SPI I/O assignments for the PIC24FJ128GA010 at pins 53 through 55.

PIC24FJXXXGB110

63	OSCI/CLKI/CN23/F
62	VDD
61	**TDO**/CN38/RA5
60	**TDI**/CN37/RA4
59	SDA2/CN36/RA3
58	SCL2/CN35/RA2
57	D+/RG2
56	D-/RG3
55	VUSB
54	VBUS
53	**RP15**/CN74/RF8

■ FIGURE 3. This is a graphic snippet of the PIC24FJ256GB110 pinout. The #1 SPI channel I/O pins that are assigned to pins 53-55 have been reassigned to make room for the USB portal interface. When the USB features are utilized, the PIC24FJ256GB110's I/O pins RG2 and RG3 are also commandeered by the PIC24FJ256GB110's USB subsystem. Note that pin 53 is a remappable I/O pin.

change SPI1 to SPI2 in the register set definitions:

```
#define ENC_SPI_IF          (IFS2bits.SPI2IF)
#define ENC_SSPBUF          (SPI2BUF)
#define ENC_SPISTAT         (SPI2STAT)
#define ENC_SPISTATbits     (SPI2STATbits)
#define ENC_SPICON1         (SPI2CON1)
#define ENC_SPICON1bits     (SPI2CON1bits)
#define ENC_SPICON2         (SPI2CON2)
```

Note that everything in the previous code snippet is now aimed at SPI2 instead of SPI1. With that bit of work behind us, the next firmware step we'll take is to define the new PIC24FJ256GB110 SPI I/O pins. This reassignment is done inside of the *HardwareProfile.h* file:

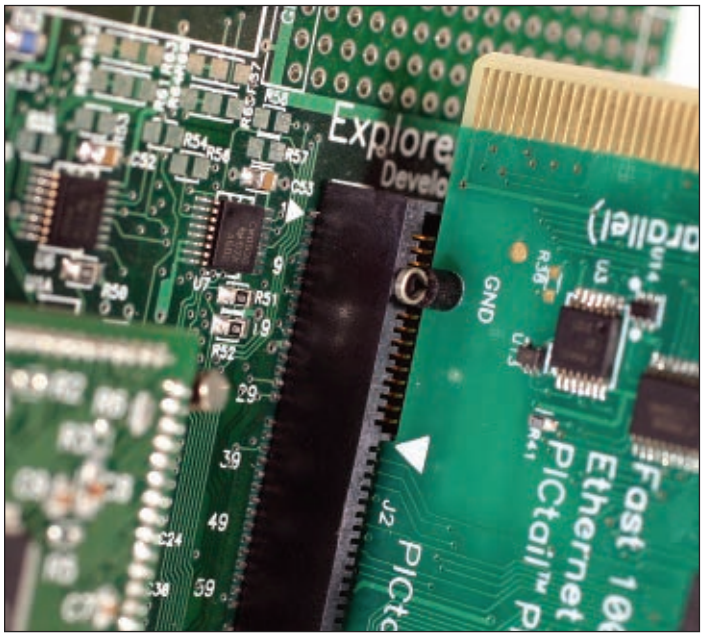
```
// SPI pinout
#define ENC100_CS_TRIS      (TRISFbits.TRISF12)
                            // CS is required
#define ENC100_CS_IO        (LATFbits.LATF12)
#define ENC100_POR_TRIS     (TRISFbits.TRISF13)
                            // POR signal is
                            // optional.
#define ENC100_POR_IO       (LATFbits.LATF13)
// SO is ENCX24J600 Serial Out, which needs to
// connect to the PIC SDI pin for SPI mode
#define ENC100_SO_WR_B0SEL
_EN_TRIS                    (TRISGbits.TRISG7)
#define ENC100_SO_WR_B0SEL
_EN_IO                      (PORTGbits.RG7)
// SI is ENCX24J600 Serial In, which needs to
// connect to the PIC SDO pin for SPI mode
#define ENC100_SI_RD_RW_TRIS(TRISGbits.TRISG8)
#define ENC100_SI_RD_RW_IO  (LATGbits.LATG8)
#define ENC100_SCK_AL_TRIS  (TRISGbits.TRISG6)
```

If you look back at Figure 4, you'll see that the new PIC24FJ256GB110 SPI pin assignments we just coded match up with the pin set composed of pins 33 through 62. You can also see that we had to move the SPI2 CS pin from RD14 to RF12. Our application doesn't use the POR signal. However, I didn't see a need to eliminate it. So, I moved it as well from RD15 to RF13.

Before we can use the new PIC24FJ256GB110 SPI pinouts, we must invoke the peripheral pin select functionality to map the #2 SPI pins to a set of the PIC24FJ256GB110's remappable I/O pins. The reassignment is performed in the function *InitializeBoard*, which is called from the main application code:

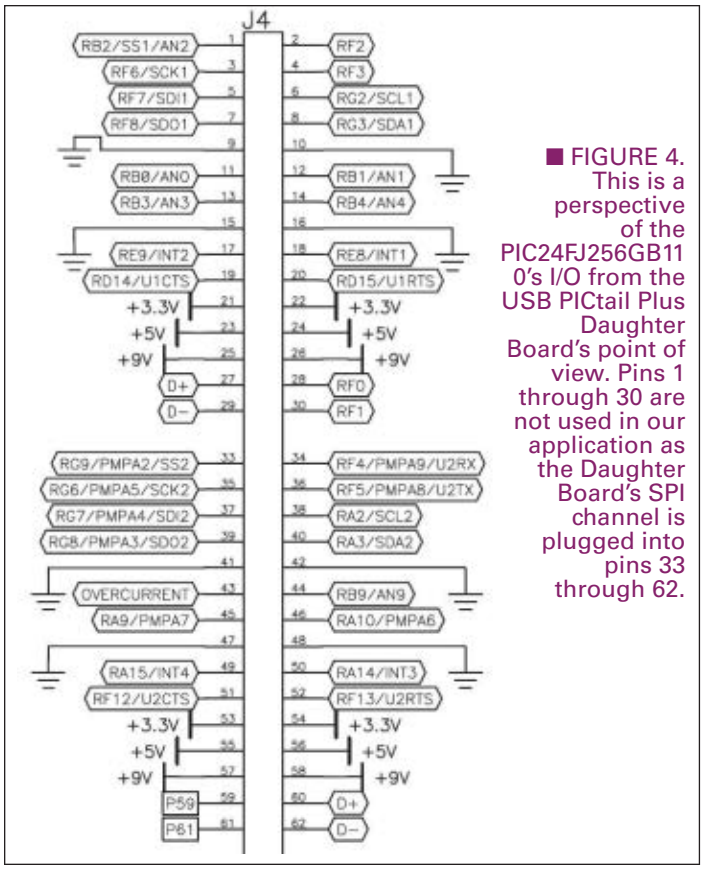
```
static void InitializeBoard(void)
{

    // Inputs
    RPINR22bits.SDI2R = 26;          //SDI2 = RP26

    // Outputs
    RPOR10bits.RP21R  = SCK2OUT_IO; //RP21 = SCK2
    RPOR9bits.RP19R   = SDO2_IO;    //RP19 = SDO2


    // Lock the PPS
    asm volatile (    "mov #OSCCON,w1 \n"
                      "mov #0x46, w2 \n"
                      "mov #0x57, w3 \n"
                      "mov.b w2,[w1] \n"
                      "mov.b w3,[w1] \n"
                      "bset OSCCON, #6");
```

Here's what's going on in the *InitializeBoard* function

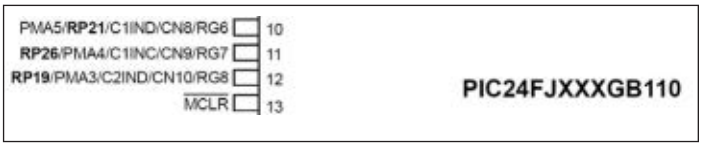


■ PHOTO 5. Note that the Fast 100 Mbps Ethernet PICtail Plus Daughter Board is plugged into the Explorer 16 Development Board as to connect its SPI channel to the development board's #2 SPI channel interface which begins at pin 33.

code snippet. The SDI2 input pin is mapped using bits 0 through 5 of the RPINR22 register. Another look at Figure 4 tells us that SPI input SDI2 is associated with the PIC24FJ256GB110 RG7 pin. **Figure 5** associates RG7 with remappable I/O pin RP26. So, to map SDI2 to RP26, we



■ FIGURE 4. This is a perspective of the PIC24FJ256GB110's I/O from the USB PICtail Plus Daughter Board's point of view. Pins 1 through 30 are not used in our application as the Daughter Board's SPI channel is plugged into pins 33 through 62.



■ FIGURE 5.Here's peripheral pin select at its very best. RP21 will be remapped as SCK2. RP26 will become SDI2 and RP19 will be assigned to SDO2 on the PIC24FJ256GB110 #2 SPI channel.

write 26 decimal (0x1A) to bits 0 through 5 of the RPINR22 register.

Mapping peripheral pin select output pins is a bit different. Let's work through the SCK2 output pin assignment. According to Figure 4, we want to associate SCK2 to the PIC24FJ256GB110 RG6 pin. Figure 5 shows us that RG6 is kin in the peripheral pin select world to RP21. Peripheral pin select register RPOR10 contains the output mapping bits for RP21 (bits 8 through 13). To map SCK2 to RP21, we must load bits 8 through 13 of peripheral pin select register RPOR10 with the output function defined by SCK2OUT_IO. Here's the peripheral pin select output function table as written in *HardwareProfile.h* :

```
// Peripheral Pin Select Outputs
#define NULL_IO             0
#define C1OUT_IO            1
#define C2OUT_IO            2
#define U1TX_IO             3
#define U1RTS_IO            4
#define U2TX_IO             5
#define U2RTS_IO            6
#define SDO1_IO             7
#define SCK1OUT_IO          8
#define SS1OUT_IO           9
#define SDO2_IO             10
#define SCK2OUT_IO          11
#define SS2OUT_IO           12
#define OC1_IO              18
#define OC2_IO              19
#define OC3_IO              20
#define OC4_IO              21
#define OC5_IO              22
```

Output Function Number[1]	Function	Output Name
0	NULL[2]	Null
1	C1OUT	Comparator 1 Output
2	C2OUT	Comparator 2 Output
3	U1TX	UART1 Transmit
4	U1RTS[3]	UART1 Request To Send
5	U2TX	UART2 Transmit
6	U2RTS[3]	UART2 Request To Send
7	SDO1	SPI1 Data Output
8	SCK1OUT	SPI1 Clock Output
9	SS1OUT	SPI1 Slave Select Output
10	SDO2	SPI2 Data Output
11	SCK2OUT	SPI2 Clock Output
12	SS2OUT	SPI2 Slave Select Output
18	OC1	Output Compare 1
19	OC2	Output Compare 2
20	OC3	Output Compare 3
21	OC4	Output Compare 4
22	OC5	Output Compare 5
23	OC6	Output Compare 6
24	OC7	Output Compare 7
25	OC8	Output Compare 8
28	U3TX	UART3 Transmit
29	U3RTS[3]	UART3 Request To Send
30	U4TX	UART4 Transmit
31	U4RTS[3]	UART4 Request To Send
32	SDO3	SPI3 Data Output
33	SCK3OUT	SPI3 Clock Output
34	SS3OUT	SPI3 Slave Select Output
35	OC9	Output Compare 9
37-63	(unused)	NC

Note 1: Setting the RPORx register with the listed value assigns that output function to the associated RPn pin.
2: The NULL function is assigned to all RPn outputs at device Reset and disables the RPn output function.
3: IrDA® BCLK functionality uses this output.

■ FIGURE 6. Unlike peripheral pin select input pin assignments, the peripheral pin select output pins are remapped according to a predefined function.

The *HardwareProfile.h* peripheral pin select list is taken from the table in **Figure 6.** Thus, writing a output function number value of decimal 11 to bits 8 through 13 of the RPOR10 peripheral pin select register maps the #2 SPI channel SCK2OUT output to pin 10 of the PIC24FJ256GB110.

Using the same peripheral pin select methodology for output SDO2, we write an output function number of decimal 10 to the peripheral pin select register RPOR9 to map the SDO2 output pin to remappable I/O pin RP19, which is associated with PIC24FJ256GB110 pin RG8.

The peripheral pin select lock code is optional. Executing the lock assembler instructions only allows one write to the peripheral pin select registers. Only a device Reset will allow another write to these registers.

At this point, we can add the Daughter Board to the hardware configuration by attaching it to the development board's J9 edge connector. The hardware and the firmware behind its configuration are ready to roll.

BRINGING UP USB

Most of the USB work is already done for us. All we really have to do is integrate the MCHPFSUSB Framework components into our MPLAB IDE configuration. To help you get USB up and running quickly, I've supplied the entire MPLAB project for you to use as a reference. I don't think you'll have any problems as we have walked this USB road together before in past Design Cycle discussions.

The only modification I made to the MCHPFSUSB Framework files was a purely cosmetic change in the *usb_descriptors.c* file:

```
//Product string descriptor
ROM struct{BYTE bLength;BYTE bDscType;WORD
string[23];}sd002={
sizeof(sd002),USB_DESCRIPTOR_STRING,
//{'C','D','C',' ','R','S','-','2','3','2','
',
//'E','m','u','l','a','t','i','o','n','
','D','e','m','o'}
//};
{'M','A','S','T','E','R','S','
','2','0','0','9',
' ','U','S','B','-','T','O','-','T','C','P'}
};
```

Otherwise, you'll find that the USB code follows the MCHPFSUSB Framework flow unhindered. If you examine the MASTERS-Demo.c file, you'll see that USB functionality is initialized and activated in

the *InitializeSystem* function.

POWERING UP TCP/IP

Like the MCHPFSUSB Framework, all we really need to do to get the TCP/IP stack running is integrate it correctly into our MPLAB project configuration. Again, you can follow my lead on the TCP/IP stack configuration as it too is part of the same MPLAB project configuration as the MCHPFSUSB Framework.

The MASTERs Demo application operates in an identical fashion to the Ethernet MINI application you saw in the September '09 issue. We have simply replaced the low pin count PIC USB front end and the MCU portion of the PIC18F67J60 with a 16-bit PIC24FJ256GB110. The only operational change you will have to consider is that the PIC24FJ256GB110's *USB2TCPBRIDGE_PORT* is set to 9762 instead of 9761. The new *USB2TCPBRIDGE_PORT* value for this month's project can be found in the *MASTERS-Demo.c* file.

The *MASTERS_Demo.c* file contains a function I assembled called USB2TCPBridgeTask which has its roots in the native UART2TCPBridgeTask application. The *USB2TCPBridgeTask* is based on the use of the Berekely Sockets APIs, which are part of the Microchip TCP/IP stack package. The source code is heavily commented and you should be able to follow the action without a lot of head scratching.

WHAT HAVE WE DONE?

On the hardware front, we have loaded an Explorer 16 Development Board with a USB-capable PIC24FJ256GB110 16-bit microcontroller that is driving a Fast 100 Mbps Ethernet PICtail Plus Daughter Board.

Firmware in your hands following your download operation includes an application that transfers data between a Tera Term Pro session on the USB side and a Telnet session on the Ethernet side. You also have a working C source code template and MPLAB project configuration that you can use to bring up your own USB and TCP/IP applications.

Finally, you have me if any questions arise. Meanwhile, gouge another notch into the handle of your Design Cycle gun. **NV**

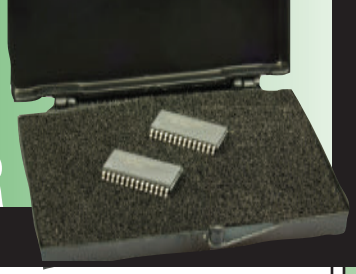
■ *Fred Eady can be contacted via email at fred@edtp.com.*

SOURCES

Microchip TCP/IP Stack
MCHPFSUSB Framework
Microchip USB PICtail Plus Daughter Board
Fast 100 Mbps Ethernet PICtail Plus Daughter Board
Explorer 16 Development Board
PIC24FJ256GB110
PIC24FJ128GA010
ENC624J600
www.microchip.com

ELECTRONET

For the ElectroNet online, go to
www.nutsvolts.com and click **Electro-Net**



BY RON HACKETT

USING THE AXE027 USB PROGRAMMING CABLE

When the first PICAXE chip was introduced (somewhere around the turn of the century!), the vast majority of PCs only had serial and parallel I/O ports. USB 1.0 had already been developed, but USB ports were not yet widely available on new PCs. As a result, PICAXE programming began with a simple serial cable interface that is still in use today. However, most new PCs (and virtually all new laptops) no longer include serial connectors. The handwriting is on the wall — the serial port is obsolete. (See the *Nuts & Volts* June 2008 article "The Serial Port is Dead! Long Live the Serial Port!") This situation presents a problem for us old-timers who have accumulated all sorts of serial port connectors and adapters for our PICAXE projects. So, in this month's Primer we're going to take a first look at how to cope with the process of migrating from serial to USB programming connections.

Before we do, however, we have a bit of "unfinished business." Since the previous installment of the Primer was published, three readers emailed me with questions that were similar enough to make me realize that a little clarification is in order. Essentially, the questions came down to: "How can a PICAXE project implement serial communication with a PC?" So, before we move on to the topic of USB programming adapters, let's take a brief look at PICAXE/PC serial communications.

COMMUNICATING WITH A PC

The serial ports on all modern PCs operate on the Electronics Industries Association (EIA) RS-232 standard, which defines a logic 0 data signal (RxD and TxD) as being between +3V and +15V, and a logic 1 data signal as being between –3V and –15V. (Voltages between +3V and –3V are not valid data signals in the RS-232 standard.) In other words, the EIA standard is based on negative logic because negative voltages represent a logic 1 (high) signal and positive voltages represent a logic 0 (low) signal. This is why PICAXE chips use the Nxxxx format for serial communication with the PC [e.g., "serout 2, N2400, (b0)"]. Of course, all PICAXE chips operate on positive voltages only (typically +5V). If you were to directly connect a PICAXE I/O pin to a PC's serial port, it's possible that you would damage or destroy the I/O pin. The function of the serial download circuit is to protect the PICAXE from any possible damage. Although the 22K and 10K resistors in the serin circuit look like a voltage divider, they actually serve a different purpose.

The 22K resistor (in combination with the internal diodes on the serin pin) clamps the input voltage levels to the PICAXE supply voltage and limits the current to prevent possible damage. The 10K resistor to ground keeps the input line from "floating" whenever the download cable is disconnected. (See the *PICAXE Manual*, Part I, page 37.)

Essentially, you have three options for implementing a serial connection between a PICAXE project and a PC. The first approach is to duplicate the serial download circuit (i.e., the 22K, 10K, and 180 Ω resistors) on two I/O pins (one for serial input and one for serial output) and use the serin and serout commands (with the Nxxxx format) to communicate with the PC. With a standard serial cable connected to the PC, you can use the Terminal Window of the Programming Editor (or your favorite terminal program) for the I/O connection to your PICAXE project. If you would rather avoid the hardware aspect of duplicating the serial download circuit, you could use a self-contained circuit such as SparkFun's RS-232 Shifter Board Kit (PRT-00133; **www.sparkfun.com**)

which also includes a female DB-9 connector for attaching a standard serial cable.

The second option involves using an RS-232 level-shifter chip such as the MAX3232. These chips include the necessary charge pump circuitry that enable them to be connected to a +5V supply, and internally generate the positive and negative voltages needed for RS-232 communications. The advantage to this approach is that the greater voltage difference between logic 0 and logic 1 levels enables serial communication over much longer distances than the TTL-level (+5V only) serial link provided by the PICAXE serial download circuit. If you want to construct your own circuit, SparkFun carries the ICL3232 chip (SKU: COM-00316) which is functionally compatible with the MAX3232. If you would rather use a PC board version, Pololu (**www.pololu.com**) carries a 23201a Serial Adapter board (fully assembled or as a kit).

In any case, it's important to remember that all RS-232 level-shifters also convert the RS-232 negative logic to positive logic on the TTL-level side, so you will need to use the Txxxx format for all your serial communications whenever a level-shifter is involved.

The third option is to simply leave the PICAXE download cable in place and use it for serial communications when your program is running. In this case, however, you can't use the serin and serout commands — only serrxd and sertxd will work with the serial input and output pins. (See the relevant documentation in Part II of the manual.) Also, the baud rate is fixed at 4800 (9600 for the X2 chips).

At first glance, this option may appear to be the simplest of the three. However, there is an additional software requirement due to the way in which PICAXE program downloads are implemented. Whenever a program is running on a PICAXE chip, in the background the chip is also repeatedly checking the serial input pin to see if the Programming Editor is about to initiate the downloading of a new program. This is a good feature; without it, we would need to have some form of a program/run switch to manually enable a new program download which would be a minor nuisance. The way the PICAXE handles this completely automates the process for us. However, if we want to use the serial input pin for a program to receive data from the PC, it's necessary to disable the background checking of the serial input pin. The disconnect command does exactly that, but you never really need to use it because whenever a serrxd command is executed, the background checking is automatically stopped anyway. However, immediately after any serrxd command is executed it's necessary for your program to issue a reconnect command to resume the background checking of the serial input pin. Failure to do so will result in not being able to download a new program to the chip. If you forget the reconnect command, the only way to re-enable program downloading is to perform a "hardware reset" — turn off power to the PICAXE, initiate a new download, and quickly turn the power back on.

A SIMPLE PC COMMUNICATIONS PROGRAM

PCserialDemo.bas is a simple demonstration of the above concepts. It's a little too long to include here — you can download it from the *N&V* website (**www.nutsvolts.com**). If you have trouble finding it, email me (Ron@JRHackett.net) and I'll send you a copy. It's also available as a Word file that includes line numbers to facilitate the following discussion. Download that version as well, and print it out for reference. The program runs on a 14M because the 08M doesn't support the required serrxd command. (It does support the sertxd command — go figure!) I didn't include a schematic because it's just the basic 14M circuit with an LED on output 5.

There are a few aspects of the program that are worthy of comment. First, the directive in Line 22 (#terminal 4800) automatically opens the Terminal Window when the program is downloaded to the 14M. In Lines 30, 37, 48, and 53, the CR and LF are pre-defined constants in PICAXE BASIC. CR stands for Carriage Return (ASCII character 13); LF stands for Line Feed (ASCII character 10).

Readers who are "mature" enough to remember typewriters will recall that both actions were required to get to the next line which is what the combination of CR and LF accomplishes. Lines 32 and 50 contain the reconnect command that must immediately follow a serrxd command in order to re-establish the automatic scanning for new downloads.

Line 34 requires a slightly more detailed explanation. As you may know, all serial data is encoded in the standard ASCII format. For example, when the user enters the 2 character from the PC keyboard, what is actually transmitted is the corresponding ASCII value. If you look on an ASCII chart (Google is your friend if you don't have one –an ASCII chart, that is), you will find that 2 corresponds to a value of 50. For all the digits (0–9), the ASCII value is 48 greater than the digit itself, so Line 34 in effect converts the entered value back from ASCII to binary so we can use it as a numerical value in our program.

Compare this to Line 52, where y and Y are used. Whenever a character (or a string, as in all the sertxd commands) is contained in quotes, we are dealing with the actual ASCII values. Finally, the end command in Line 54 is contained within the then clause of the if statement. As a result, if the user transmits either a y or a Y, then the program terminates immediately. Any other key press (including n) will cause the program to loop back to the beginning and ask the user for another number.

Okay, enough didactics! Wire up the circuit, download the program to the 14M, and leave the programming cable in place. The Terminal Window should open automatically; if it doesn't, you can always open it manually by accessing the PICAXE > Terminal menu or by pressing the F8 key. You will soon discover that (unlike most other terminal programs) you can't press the enter key in the Terminal Window to send an entered character — you need to click the send button

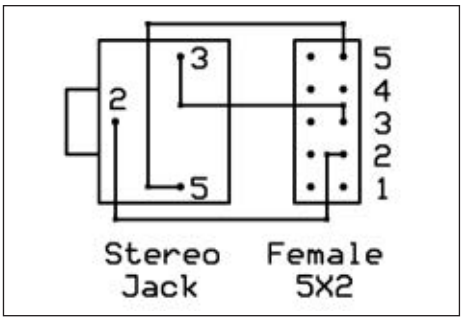
to do so. In fact, if you do press enter (and then click send as I did a couple of times), the program will misbehave because a CR character (and possibly a LF, as well) will be transmitted. As a result, the program will reject the character as not being between the values of 1 and 9, and gently admonish you to follow the directions.

You may want to experiment with modifying the program to see what happens. However, it already uses 247 bytes of the 14M's 256 bytes of program storage memory, so you won't be able to add much unless you also remove something. The easiest way to accomplish this is to shorten the two long sertxd strings. (Of course, you could always switch to a 28X1 chip which has 16 times the program memory of the 14M.) Once you are clear about how the program functions, we're ready to move on to our main topic this month.

MIGRATING TO THE AXE027 USB PROGRAMMING CABLE

It would be reasonable to assume that the topic of PICAXE USB programming adapters would be a no-brainer, since so many manufacturers already offer USB to serial adapters. However, most of them simply don't work with the PICAXE Programming Editor. Currently, the most reliable upgrade path is to use the AXE027 USB programming cable produced by Revolution Education and available at SparkFun (SKU: PGM-08312). (As an aside, if you are currently using a different USB to serial adapter and it is working reliably with your PICAXE projects, I would love to know about it. If you can send me the make, model number, and vendor from whom you purchased it, that would be great.) When I recently upgraded to a new laptop (with no serial ports), I also purchased the AXE027 USB programming cable which terminates in a mini-stereo plug that provides the necessary sin, sout, and ground connections for programming all the PICAXE chips. RevEd chose this connector because it stands up well in an educational environment where students sometimes bend and even destroy adapters that have pins on them. However, a mini-stereo plug is obviously not the most breadboard-friendly option. Also, if you are a regular Primer reader, you know that we have developed a variety of stripboard projects that are based on a standard 5X2 serial ribbon cable connection. Of course, we would want all these projects to continue to be functional with the AXE027 cable, so I quickly realized that we need an adapter for the new cable.

■ FIGURE 1. Wiring diagram for the SUSB-5X2.



CONSTRUCTING OUR FIRST USB PROGRAMMING ADAPTER

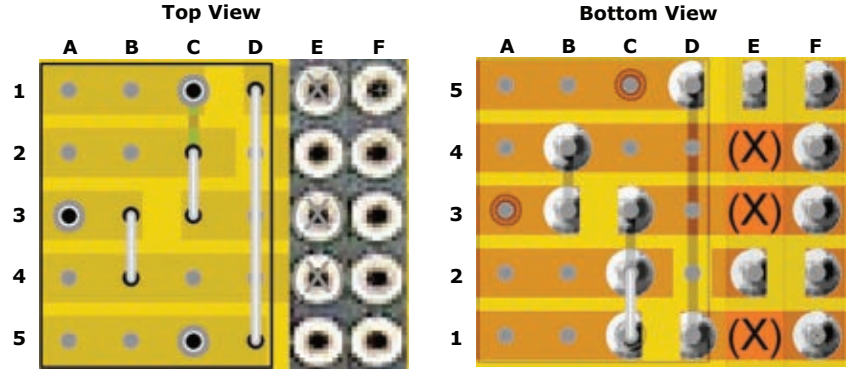
The first adapter I made (the SUSB-5X2) simply connects a mini-stereo jack to a 5X2 female header so that the pinout of the header matches that of the serial ribbon cable connector I have been using for the last three years. (See the wiring diagram in **Figure 1**.) As a result, none of my current programming adapters or project boards have become obsolete; they all can be used with either a serial ribbon cable or with the AXE027 USB programming cable attached to the SUSB-5X2 adapter. If you are still using a serial programming cable, RevEd also makes an AXE026 serial programming cable (SparkFun SKU: PGM-08313) that uses the same mini-stereo plug, so this cable can be used with the SUSB-5X2 adapter we are about to construct.

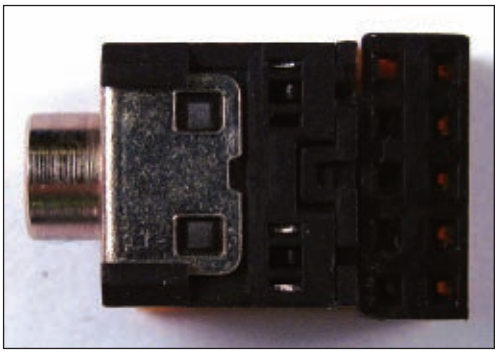
The stripboard layout for the SUSB-5X2 adapter is presented in **Figure 2**. As you can see, it's very simple. The only parts are the mini-stereo jack and the 5X2 female header (both of which are available on my website). If you use your own jack, be sure there is enough room underneath for the jumper wires when the jack is inserted into the stripboard.

The holes in the stripboard are slightly too small for the pins of the jack that I used. If you use the same one, you will need to either drill the three holes slightly larger (a 3/64th drill bit works fine) or file the pins so they are slightly thinner. Either approach is relatively easy because it doesn't take much to get the pins to fit. (It also helps to straighten the pins before inserting them into the stripboard.)

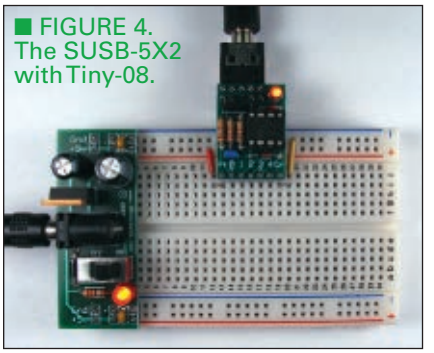
There are two additional minor modifications that need to be made to the mini-stereo jack before it's soldered into place. First, there is a plastic post that would sit at position C3 of the stripboard layout – snip it off. Second, there is a pin that would fit in the hole

■ FIGURE 2. Stripboard layout for the SUSB-5X2.





■ FIGURE 3. The completed SUSB-5X2.



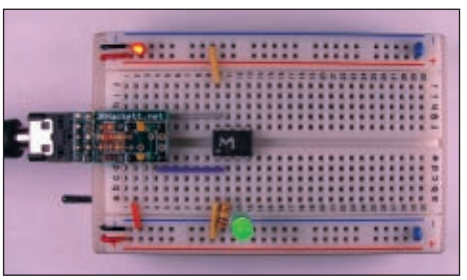
■ FIGURE 4. The SUSB-5X2 with Tiny-08.

at position C4 – again, snip it off.

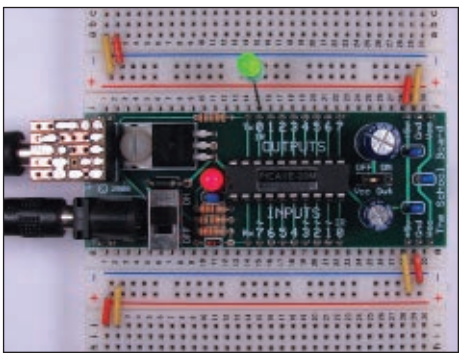
The 5X2 female header also requires a minor modification. Before soldering it in place, remove the pins at the positions marked with (X). This is surprisingly simple to do — they easily pull out from the bottom using needle-nose pliers. The actual assembly of the stripboard is very straightforward.

First, install all the jumpers but don't solder the jumper connections at C1 and C2 yet. Next, insert the 5X2 header (making sure that the missing pins are in the correct locations) and solder the header in place. Finally, insert the mini-stereo jack and bend the jumper on the bottom of the board from C2 to C1 so that it's touching the jack's pin at C1. Then, solder the connections at C1, C2, C5, and A3.

■ FIGURE 5. The SUSB-5X2 with UPA-4X4.



■ FIGURE 6. The SUSB-5X2 with the School Board.

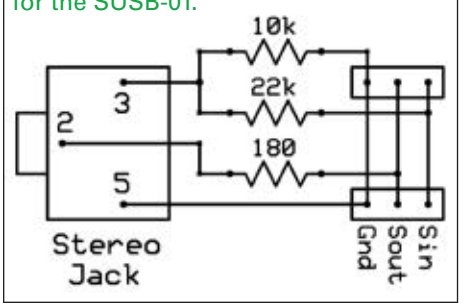


When all the connections have been soldered, sand or file any sharp edges and clean the bottom of the board.

Figure 3 is a photo of the completed SUSB-5X2 adapter and **Figures 4, 5,** and **6** show how it's used in three different situations. In Figure 4, the SUSB-5X2 connects the AXE027 USB cable to the Tiny-08 project board. Figure 5 shows how the SUSB-5X2 can be used to convert the UPA-4X4 programming adapter for a USB connection to the PC. You don't see a power supply in Figure 5 because the breadboard is mounted on a small plastic project box with a battery-powered five-volt supply inside. (See the December 2008 installment of the Primer for construction details.)

Don't forget to include the 100K resistor that ties the serin line to ground. Without it, any program you have installed in the PICAXE won't run when the programming adapter is removed from the circuit. In Figure 6, the SUSB-5X2 is flipped upside-down, inserted into the 5X2 male header on the School Board with the AXE027 cable attached. As you can see, this simple little adapter enables all of our previous serial connections to continue to function in the Brave New [USB] World! Nevertheless, I couldn't stop at just one adapter.

■ FIGURE 7. The schematic for the SUSB-01.



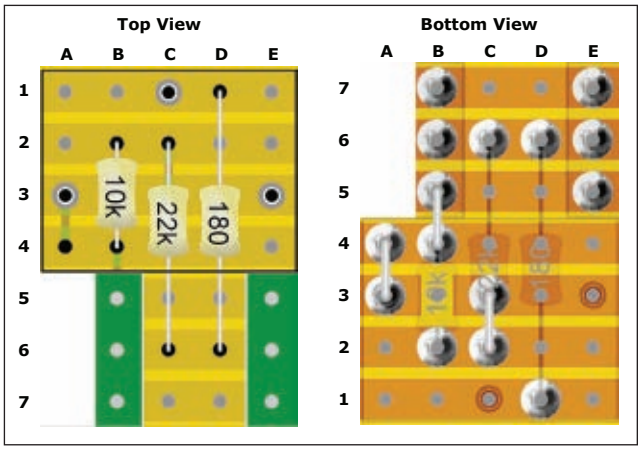
(Does anyone know a good Programming Adapters Anonymous group I could join?)

CONSTRUCTING OUR NEXT (AND CERTAINLY NOT LAST!) PROGRAMMING ADAPTER

Our next programming adapter (the SUSB-01) combines the mini-stereo jack and the standard PICAXE programming circuit into one convenient stripboard circuit. Its schematic is presented in **Figure 7**. You will notice that I haven't included the BAT85 diode. Since the AXE027 cable converts the voltage levels to standard five-volt TTL, the diode is not necessary. The stripboard layout for the circuit is shown in **Figure 8**.

The only thing that is unusual about the circuit is that the stripboard has a small notch in it. The notch is not at all necessary — the board will function perfectly well without it. I just wanted as much room as possible on the breadboard for the necessary connections to the PICAXE processor.

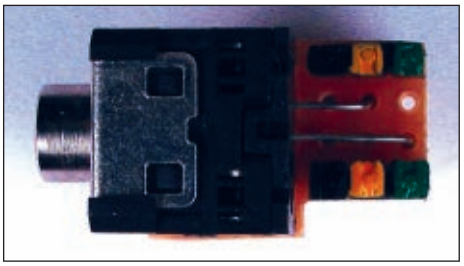
Construction of the board is very straightforward, with one caveat. The three resistors must each be the smaller 1/6 watt version in order to fit under the stereo jack. Install the resistors first, but don't solder the 10K lead at B4 yet. Also, don't forget to bend and extend the other 10K lead on the bottom of the board from C2 to C3 and solder it at both positions. (That's exactly what I forgot to do and it took me a while to figure out why the board didn't work at first!) Next, reverse-mount the two three-pin male headers. (Don't forget that they need to be the longer version to be suitable for reverse-mounting). On the bottom of the board, bend the 10K lead from B4 to B5, snip it so that it just touches the header pin at B5, and solder the six header pins and the 10K lead at B4. Next, insert the mini-stereo jack and attach a short jumper on the bottom of the board from its pin at A3 to the adjacent trace at A4. Finally, solder the pins at E3, C1, and A3, and the



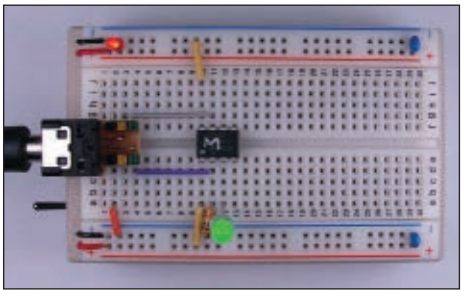
■ FIGURE 8. Stripboard layout for the SUSB-01.

jumper to the trace at A4. **Figure 9** is a photo of the completed SUSB-01 adapter. In it, you can see that I have painted the tops of the male header pins in my standard color scheme (black = ground, yellow = sout, and green = sin) to help me make the correct connections to the PICAXE processor. **Figure 10** shows the SUSB-01 installed on the same breadboard I used earlier in Figure 5. Again, be sure to include the 100K resistor that ties the serin line to ground so that your project will still function correctly when the SUSB-01 is removed from the circuit.

With these two additional boards in our arsenal, all of our previous stripboard programming adapters and project boards will continue to function, either with a serial or a USB programming connection. As I mentioned earlier, if you have a USB adapter other than the AXE027 cable and it has been working with your PICAXE projects, let me know. I would like to develop a list of PICAXE-compatible USB adapters and place it on my website. I know there are several USB adapters for the Arduino processors but apparently they don't work with the Programming Editor, at least not without modification. As soon as I get the time, I plan to do some experimentation with a couple of them – I'll keep you posted on my progress (or lack thereof).



■ FIGURE 9. The completed SUSB-01.



■ FIGURE 10. The SUSB-01 on a breadboard.

WHAT'S NEXT?

In the next Primer installment, we're going to turn our attention to seven-segment LED displays. First, we'll conduct a couple of simple programming experiments with a single-digit LED display and a 20M processor. Then, we'll turn our attention to the MAX7219 serially interfaced LED display driver which greatly simplifies the circuitry normally required to interface multiple LED displays with a microcontroller. We'll take advantage of this simplification to develop a four-digit peripheral LED display for use in our upcoming projects.

In the meantime, if you want to familiarize yourself with the 7219, you may want to download a copy of the datasheet (available at **http://datasheets.maxim-ic.com/en/ds/MAX7219-MAX7221.pdf**). See you next time! **NV**

Check the *Nuts & Volts* website at **www.nutsvolts.com** for accompanying downloads.

Order online at:
www.melabs.com

Development Tools for PIC® MCUs
microEngineering Labs, Inc.

Phone: (719) 520-5323
Fax: (719) 520-1867
Box 60039
Colorado Springs, CO 80960

USB Programmer for PIC® MCUs
$89.95 (as shown)
RoHS Compliant
Programs PIC MCUs including low-voltage (3.3V) devices
Includes Software for Windows 98, Me, NT, XP, and Vista.
With Accessories for $119.95: Includes Programmer, Software, USB Cable, and Programming Adapter for 8 to 40-pin DIP.

LAB-X Experimenter Boards
Pre-Assembled Board
Available for 8, 14, 18, 28, and 40-pin PIC® MCUs
2-line, 20-char LCD Module
9-pin Serial Port
Sample Programs
Full Schematic Diagram
Pricing from $79.95 to $349.95

BASIC Compilers for PICmicro®
Easy-To-Use BASIC Commands
Windows 98/Me/2K/XP/Vista
PICBASIC™ Compiler $99.95
BASIC Stamp 1 Compatible
Supports most 14-bit Core PICs
Built-In Serial Comm Commands
PICBASIC PRO™ Compiler $249.95
Supports most PICmicro® MCU Families
Direct Access to Internal Registers
Supports In-Line Assembly Language
Interrupts in PICBASIC and Assembly
Built-In USB, I2C, RS-232 and More
Source Level Debugging

EPIC™ Parallel Port Programmer starting at $59.95

PICPROTO™ Prototyping Boards
Double-Sided with Plate-Thru Holes
Circuitry for Power Supply and Clock
Large Prototype Area
Boards Available for Most PIC® MCUs
Documentation and Schematic
Pricing from $8.95 to $19.95

See our full range of products, including books, accessories, and components at:
www.melabs.com

We have over 170 related titles in our webstore!!

The Nuts & Volts WEBSTORE

CD-ROMS SPECIALS

ELECTRONIC NEWBIE

DIY Design Electronics Kit

This great kit contains everything you need to learn the basics of electronic circuit design. It contains all of the most common electronics components as well as a prototyping breadboard for you to get started right away.

The kit has over 130 parts!

No soldering is required and the included 32 page illustrated manual guides you through each of the projects. After you build all of the projects, you can use the parts for your own designs.

For a complete product detail, please visit: http://store.nutsvolts.com **$49.95***

ELECTRONICS

Beginner's Guide to Embedded C Programming Volume 2
by Chuck Hellebuyck

In this "Volume 2," Chuck takes the reader to the next level by introducing how to drive displays, how to use interrupts, how to use serial communication, and how to use the internal hardware peripherals of the PIC16F690 microcontroller such as SPI, PWM, and timers. When you have finished reading this book and completed the projects, you'll be well beyond the title of Beginner!
$39.95

The components that are added to the PICKit 2 that Chuck uses in his new book can also be purchased through the *Nuts & Volts* Webstore.
$12.95

Running Small Motors with PIC Microcontrollers
by Harprit Singh Sandhu

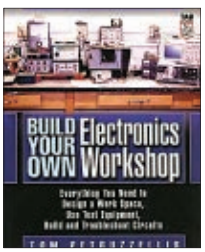
NEW!

The only comprehensive guide to using PIC microcontrollers to drive small motors.

Running Small Motors with PIC Microcontrollers contains more than 2,000 lines of PICBASICPro code and dozens of circuit diagrams with the focus on controlling motors. Hands-on tutorials, program listings, and resources are included. **$29.95**

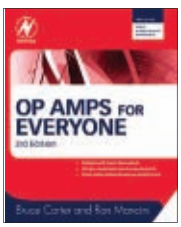
Build Your Own Electronics Workshop
by Thomas Petruzzellis

YOUR DREAM ELECTRONICS LAB IS WAITING INSIDE!



This value-packed resource provides everything needed to put together a fully functioning home electronics workshop! From finding space to stocking it with components to putting the shop into action — building, testing, and troubleshooting systems — popular electronics author Tom Petruzzellis' *Build Your Own Electronics Workshop* has it all! And the best part is, this book will save you money, big time!
Reg $29.95 Sale Price $24.95

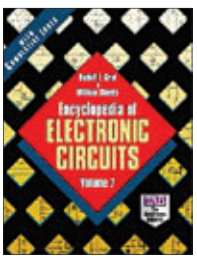
Op Amps for Everyone, Third Edition
by Bruce Carter and Ron Mancini



OP AMPS FOR EVERYONE provides the theoretical tools and practical know-how to get the most from these versatile devices - this new edition substantially updates coverage for low-speed and high-speed applications, and provides step by step walkthroughs for design and selection of op amps and circuits.
$79.95*

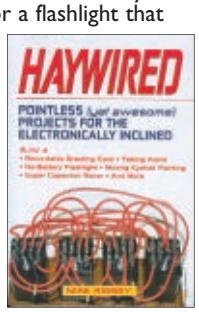
Encyclopedia of Electronic Circuits, Volume 7
by Rudolf F. Graf / William Sheets

NEW IN THE BESTSELLING SERIES! ONE THOUSAND MORE LEADING-EDGE CIRCUIT DESIGNS!



Designed for quick reference and on-the-job use, the *Encyclopedia of Electronic Circuits, Volume 7*, puts over 1,000 state-of-the-art electronic and integrated circuit designs at your fingertips. Organized alphabetically by circuit type, this all-new collection includes the latest designs from industry giants such as Advanced Micro Devices, Motorola, Teledyne, General Electric, and others.
$39.95

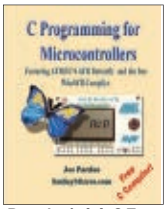
Haywired
by Mike Rigsby



Construct a no-battery electric car toy that uses a super capacitor, or a flashlight that can be charged in minutes, then shines for 24 hours. Written for budding electronics hobbyists, author Mike Rigsby offers helpful hints on soldering, wire wrapping, and multimeter use. Each project is described in step-by-step detail with photographs and circuit diagrams. Includes websites listing, suppliers and part numbers.
$16.95

Order online @ www.nutsvolts.com
Or CALL 1-800-783-4624 today!

BOOK & KIT COMBOS



From the Smiley Workshop

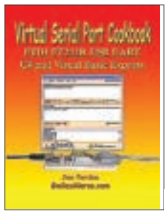
C Programming for Microcontrollers
by Joe Pardue

Book **$44.95**

Kit **$66.95**

Do you want a low cost way to learn C programming for microcontrollers? This 300 page book and software CD show you how to use ATMEL's AVR Butterfly board and the FREE WinAVR C compiler to make a veryinexpensive system for using C to develop microcontroller projects.

Combo Price $99.95 Plus S/H



Virtual Serial Port Cookbook
by Joe Pardue
As talked about in the
Nuts & Volts June issue,
"Long Live The Serial Port"

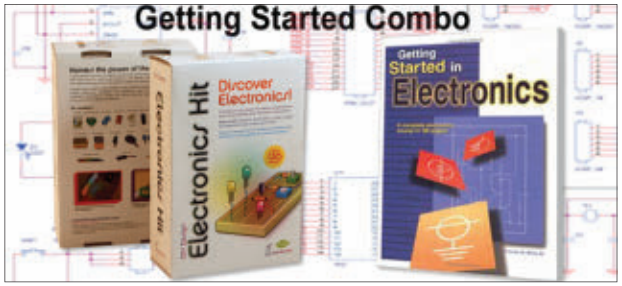
Book **$44.95**

Kit **$69.95**

This is a cookbook for communicating between a PC and a microcontroller using the FTDI FT232R USB UART IC. The book has lots of software and hardware examples. The code is in C# and Visual Basic Express allowing you to build graphical user interfaces and add serial port functions to create communications programs.

The Virtual Serial Port Parts Kit and CD
(also *available, above right*)

Reg. Price $ 114.90 **Subscriber Price $109.95 Plus S/H**



The Getting Started Combo includes: Getting Started in Electronics by Author Forrest Mims and the DIY Electronics Kit. In his book, Mims teaches you the basics and takes you on a tour of analog and digital components. He explains how they work and shows you how they can be combined for various applications. The DIY Electronics Kit allows for the hands-on experience of putting circuits together -- the kit has over 130 parts! No soldering is required and it includes its own 32 page illustrated manual. **Combo Price $62.95 Plus S/H**

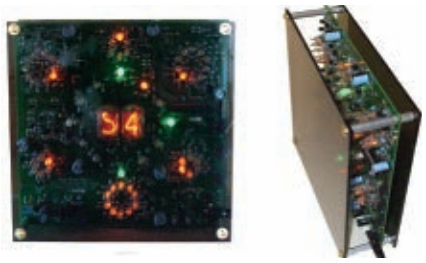
THE EVIL GENIUS SERIES

CD-ROMS

CALL 1-800-783-4624 today!
Or Order online @ www.nutsvolts.com

PROJECTS

NixieNeon Clock Kit



Using Neon and Nixie bulbs, this clock displays the precision movement of time and is programmable to display "Time Chaos" at different intervals. The NixieNeon Clock then resets itself to the correct time in an eye-catching ballet of luminosity.
The PCB is 7.25"x 7.25" and consists of over 400 components.
Subscriber's Price **$186.00**
Non-Subscriber's Price **$195.95**
PCBs can be bought separately.

Retro Game Kit

Build your own "BLAST from the Past!"
This is sure to be a hit for all ages! Easy to build in an evening and will give you many more fun filled evenings mastering the Retro Rover or Retris games.
Games come preprogrammed on individual MCUs
Reg $44.95 Sale Price **$29.95**
Limited Time Offer

Arch-Ball Clock PCB & MCU

This unique clock allows the hobbyist to be involved with a little wood working, as well as the electronics side of the project. We just supply you with the custom shaped printed circuit board and the programmed MCU. You'll have to go digging in your workshop for the other components and wood.
Subscriber's Price **$25.75**
Non-Subscriber's Price **$28.25**
Arch templates can be downloaded from the *Nuts & Volts* website.

Transistor Clock Kit

If you like electronic puzzles, then this kit is for you! There are no integrated circuits; all functionality is achieved using discrete transistor-diode logic. The PCB is 10"x11" and harbors more than 1,250 components!
For more info, see page 42, this issue.
Subscriber's Price **$214.95**
Non-Subscriber's Price **$225.95**
PCBs can be bought separately.

Nixie Tube Clock Kit

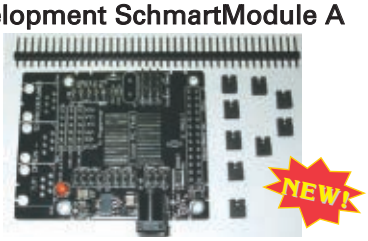
Cherry Wood Clock Case

October 2006

Nixie tube clocks fuse the spirit, drama, and eerie beauty of cold war technology with modern inner works to create uncommon handcrafted timepieces.

Now with optional case choices!
Get more info @
www.nutsvolts.com
Subscriber's Price **$146.95**
Non-Subscriber's Price **$159.95**
Kit includes article reprint, complete instructions and parts list.

8 Bit PIC® Microcontroller Development SchmartModule A



This PIC Microcontroller Development board supports 116 different 8 bit SOIC PIC Microcontrollers. This board is fully populated except for the PIC. You hand-solder the PIC using the "EZ" technology from *Schmart Board*, configure the jumpers for your PIC part number, and start programming.
For more on "EZ" technology, please see this product in our webstore. **$14.95**

Talking Skull Kit

Get ready for a tech-scary Halloween!
For more information, please visit
http://store.nutsvolts.com
Subscriber's Price **$69.95**
Non-Subscriber's Price **$73.75**
Also available fully assembled Skulls & Talking Skull Audio Board

CAR P300-120 Audio Board Kit

New for 2009, optional CAR P300-120 Audio Board can be added to this kit. See Talking Skull Updates in *Nuts & Volts* September issue pg 87.

Subscriber's Price **$69.95**
Non-Subscriber's Price **$73.75**

Das BlinkenBoard Kit

This kit includes a preprogrammed ATtiny84 microcontroller that sports eight software PWM channels to control motor speed and light brightness. Jumper selectable patterns can be used to operate motors, solenoid valves, relays. Expand your board with GNU/GPL software updates to be featured in upcoming *NV* articles.

Subscriber's Price **$32.45**
Non-Subscriber's Price **$35.95**
PCBs can be bought separately.

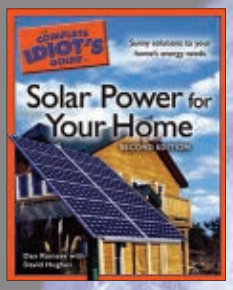
WE ACCEPT VISA, MC, AMEX, and DISCOVER. Prices do not include shipping and may be subject to change.

Attention **Subscribers ask about your discount on prices marked with an ***

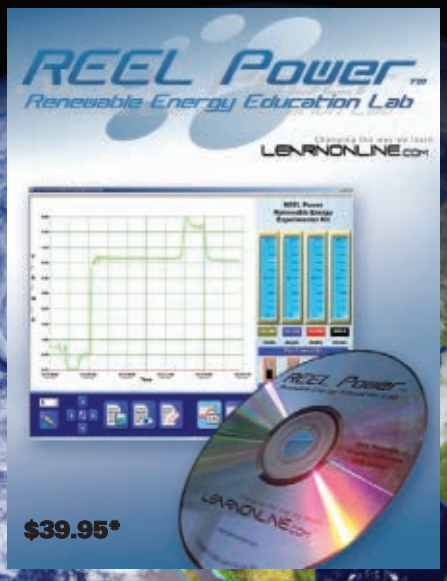
The Nuts & Volts **WEBSTORE**

ALTERNATIVE ENERGY SECTION

The Complete Idiot's Guide to Solar Power for Your Home
by Dan Ramsey / David Hughes

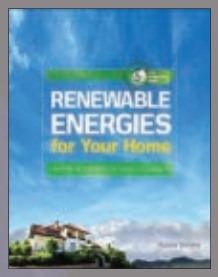


The perfect source for solar power — fully illustrated. This book helps readers understand the basics of solar power and other renewable energy sources, explore whether solar power makes sense for them, what their options are, and what's involved with installing various on- and off-grid systems. **$19.95**



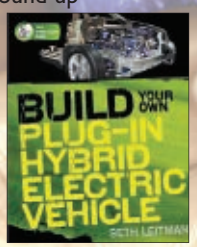
$39.95*

Renewable Energies for Your Home
by Russel Gehrke
Simple and Inexpensive Renewable Energy Solutions for Your Home.



It's not always easy being green, and sometimes it costs more than you'd expect to get an eco-friendly home improvement project up and running. *Renewable Energies for Your Home* gives you sustainable home energy solutions that won't drain your wallet or the power grid. Filled with step-by-step instructions and helpful photos and illustrations. **$24.95**

Build Your Own Plug-In Hybrid Electric Vehicle
by Seth Leitman
A Step-by-Step Guide to Building a Plug-In Hybrid Electric Vehicle from the ground up

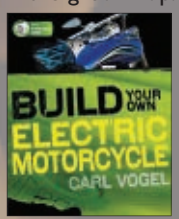


Build Your Own Plug-In Hybrid Electric Vehicle puts you in the driver's seat when it comes to hitting the road in a reliable, economical, and environmentally friendly ride. Inside, you'll find complete details on the hybrid powertrain and all the required components, including the motor, battery, and chassis. **$24.95**

50 Green Projects for the Evil Genius
by Jamil Shariff

Using easy-to-find parts and tools, this do-it-yourself guide offers a wide variety of environmentally focused projects you can accomplish on your own. Topics covered include transportation, alternative fuels, solar, wind, and hydro power, home insulation, construction, and more. The projects in this unique guide range from easy to more complex and are designed to optimize your time and simplify your life! **$24.95**

Build Your Own Electric Motorcycle
by Carl Vogel
A practical guide for building an electric motorcycle from the ground up.



Complete with hundreds of step-by-step pictures, charts, and graphs for the latest and most efficient technologies, this new TAB Green Guru Guide shows you how to build an electric motorcycle from scratch. Written by an electric vehicle expert, *Build Your Own Electric Motorcycle* provides current data on all required materials, components, and specifications. **$24.95**

SPECIAL OFFER

Making PIC Microcontroller Instruments and Controllers
by Harprit Sandhu

Harness the power of the PIC microcontroller unit with practical, common-sense instruction from an engineering expert. Through eight real-world projects, clear illustrations, and detailed schematics, *Making PIC Microcontroller Instruments and Controllers* shows you step-by-step how to design and build versatile PIC-based devices. **Reg $49.95**
Sale Price $42.95

CLASSIFIEDS

SURPLUS

SURPLUS ELECTRONIC PARTS & ACCESSORIES

Over 13,000 Items in Stock.

Cables, Connectors, Displays, Fans
Hardware, LEDs, Motors, Potentiometers
Relays, Semiconductors, Service Manuals, Speakers
Switches, Test Equipment, Tools, VCR Parts

Surplus Material Components
SMC ELECTRONICS
www.smcelectronics.com

No Minimum Order.
Credit Cards and PAYPAL Accepted.
Flat $4.95 per order USA Shipping.

COMPONENTS

RF PARTS™ CO.
Tubes, Transistors, Power Components
Email: rfp@rfparts.com • Web: www.rfparts.com
800-737-2787 Fax 888-744-1943

KITS/PLANS

QKITS.COM

50 AMP PWM
1-888-GO 4 KITS

Electronic Kits
• Fun and Educational
• Discount White and Blue LEDs
• Quantity Discounts

www.bakatronics.com

VIDEO AGC/SYNC PROCESSING PROJECT
AVR RISC Microcontroller-Based
Instruction Manual CD's
Printed Circuit Boards
Pre-programmed Microcontrollers
Free Patent Application Information
www.jlkelectronics.com

Did you know that if you're a paid subscriber to *Nuts & Volts*, you can get the online version for *FREE*? Go to www.nutsvolts.com.

Brilldea
purveyor of prototyping goods
+RGB LED Ribbon
+RGB LED Pixels
+LED Painter
+Parallax Propeller
+LED Lumen
+3.0" LCD w/ composite video input
www.brilldea.com

uM-FPU V3.1
Floating Point Coprocessor

32-bit IEEE 754
SPI or I2C
DIP-18, SOIC-18

Fast – Easy to Use
Extensive floating point support, GPS input, FFT, 12-bit A/D, matrix operations, user-defined functions.
www.micromegacorp.com

LEDs
Super Brights from 20¢
RGB Color Mixing 30 Pack $6.99
Assortment 120 Pack $24.99
Shipping from $3.00
Alan-Parekh.com/Store

Nixie Power

2-16V In, 4-8W / 150-200VDC Out
0.95" x 0.95" x 0.35"
$9.95 (Shipping included)
www.tayloredge.com/nixie

SCSI
I-U320 50Pin-68Pin-80Pin
1 to 8 Bay Case Enclosures
Adapters Cables Terminators
Low Prices - Qty Discounts!
(Also FireWire, USB, Video)
www.mcpb.com

SOLAR PRODUCTS/KITS

BATTERY DESULFATORS
www.wizbangplus.com

MISCELLANEOUS FOR SALE

WANT TO BUY ...
Electronic distributing or manufacturing company
Anything considered. Inventory, equipment, fixtures, entire company. Call ISE at no cost or obligation.
PH: 956-444-0004 (toll free) 888-351-5550
tommy@iseliquidator.com www.iseliquidator.com

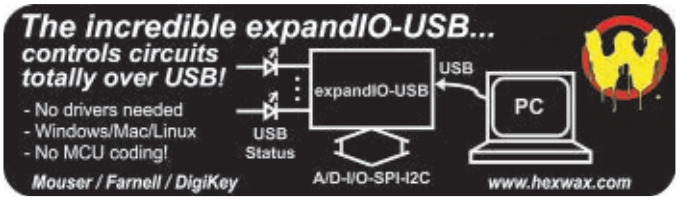
BOOKS

Books
PIC® Microcontroller
sq-1.com
Stepper Motors
stepperstuff.com
CNC
cncintro.com
SQUARE 1 ELECTRONICS
(208) 664-4115
Hayden, ID USA

www.servomagazine.com

MICROCONTROLLERS

The incredible expandIO-USB...
controls circuits totally over USB!
- No drivers needed
- Windows/Mac/Linux
- No MCU coding!



Mouser / Farnell / DigiKey
www.hexwax.com

HARDWARE WANTED

DEC EQUIPMENT WANTED!!!
Digital Equipment Corp.
and compatibles.
Buy - Sell - Trade
CALL KEYWAYS 937-847-2300
or email buyer@keyways.com

WANTED
used - surplus - obsolete
radios, tvs, capacitors, inductors
transistors, RF parts, meters, dials
heatsinks, switches, transformers
antennas, test equipment, crystals
tubes, connectors, motors, manuals
www.SecondHandRadio.com

www.nutsvolts.com

GADGETS

GREEN LASER POINTER

.93 mile range
$22.89 Free Shipping
www.gadgetcentral.ca

MicroStamp11
World's Smallest 68HC11 Microcontroller Module!

- telemetry
- smart toys
- animatronics
- microrobotics
- model railroading
- home automation

Ideal for college and hobby projects!

- tiny, light-weight module
- choice of 8K or 32K EEPROM
- SCI, SPI, pulse accumulator
- generate pulses, PWM, etc.
- measure time, frequency, etc.
- 14 digital I/O lines + interrupts
- use Assembler, BASIC, or C
- lots of code examples/tutorials
- easy Windows code-loading
- Starter Packages from $49

www.MicroStamp11.com

LCDs/DISPLAYS

continued from page 10

ENLIGHTENED ABOUT SOLAR

I have been tossing around solar PV system ideas for a number of years and am inspired by the Solar Tracker project and the solar energy article in the August issue. This is an interesting and important subject and I would love to see more like it. I've noticed that most of the commercial and residential solar installations are fixed, although possibly a few track the sun from east to west. Almost all are tilted to compensate for the latitude and I would guess that the gain in power does not merit the added power and maintenance of active aiming in the north-south plane. For that configuration in a residential installation — with tax incentives — I estimate payback is about 30 years (Southern Oregon). Even so, I'm still interested in pursuing solar power if only for exterior/garden lighting and attic exhaust fans.

As the author begins his engineering career, he will realize that completing a prototype is just the first or second step in building a product. The next step is characterization to demonstrate the correctness and limits of his design. If he has the time, it would be interesting to know how much power is actually generated by the array and how much power is dissipated by the control and computation blocks of the system. Would it save energy to skip the altitude aiming and just track the azimuth (east-west)? Is the reason most arrays are not aimed due to minimal gains in efficiency or the cost of building and maintaining the aiming mechanism? What about just calculating the sun's position (maybe a math major needs to be added to the team) and aim the array open loop? Also, a real time clock could shut down the aiming mechanism after the sun goes down to gain some efficiency. I know that the time constraints on this project limited consideration of some of these options, but might make an interesting follow-up article.

Steve McChrystal

*Thank you for writing! You're right; as I am a new engineer, there are many things I have yet to learn and experience. For example, during the design phase of the Solar Tracker, I built several small prototypes of its different sub-systems before completing [what I considered to be] the finished product. Little did I realize that my finished product was merely a prototype itself! Yes, if I were actually trying to take this to market (with the necessary time and capital), there would be many more tests to run and a reevaluation of the design. There are several areas that could be improved upon, but this was only a Senior Design project (the first one to actually work in several years) and we were pleased. My day job now is lighting, power, and system design for new and rennovated buildings; so product design isn't something I do on a daily basis. I have, however, worked in the petro-chemical field and have designed dozens of very large, very complex industrial systems for oil refineries. I run the West Virginia Robotics Club (**www.wvrc.us**), design many electronics/robotics projects, and have just completed a kit for the WV Department of Education. I'm new at this, but I've hit the ground running!*

You're absolutely right about the altitude tracking vs. extra energy consumption trade-off, which is why most (if not all) commercial solar tracking devices only perform azimuth tracking, if not entirely fixed, with perhaps adjustment screws to compensate for the earth's tilt on its axis. Believe it or not, solar panels (as the technology exists today) are only about 43% energy efficient at best, and solar tracking doesn't really add that much benefit. Thanks again for writing!

Samuel Aaron Ward

CLASSIFIEDS

PROFESSIONAL SERVICES

RICHARD N. KRAJEWSKI
Editor
201-659-0041
richardkrajewski.com

DESIGN/ENG SERVICES

*Circuit board layouts
*Prototype assemblies
WWW.OSPREYELECTRONICS.COM
Convert your sketch or print into a quality pcb for a reasonable price. Visit us on the web or call Osprey Electronics at (208) 664 1089 (USA)

FLEXREV China Direct Manufacturing
Turn Key or Subassemblies
Components,Enclosures, Keypads
$0.007 per soldering point
2 layer PCBs $0.14/in2
Small jobs welcome
FLEXREV.COM

PCB SOFTWARE

EXCLUSIVE U.S. DISTRIBUTOR

YOUR COMPLETE SOLUTION!
- PCB Design
- PCB Simulation
- CAD/CAM Menu
121747, Hobby Vers., $175
121743, Pro. Version, $275
www.KELVIN.com

ROBOTICS

$29.95 (MSRP) MaxSonar-EZ1
High Performance Ultrasonic Range Finder
- serial, analog voltage & pulse width outputs
- lowest power - 2mA
- narrow beam
- very easy to use!
www.maxbotix.com

AUDIO/VIDEO

www.mat-co.com
Hand-Held Multifunction CCTV Tester
- Portable installation video monitor
- Video signal generator to test monitor or DVR
- PTZ controller with multi-protocol
- PTZ analyzer to determine protocol type
- UTP cable tester to test for direct & cross-over cable
$469/ea
(800)719-9605 eversecure@matco.com

www.mat-co.com
Snake Inspection Camera
- View dark inaccessible spaces
- 3'2" flexible extension cable bends in any direction with precise image
- Lighted with LED
- IP67 Waterproof camera
- 2.4" TFT LCD Monitor
- Powered by 4 AA bateries
$199/ea
(800)719-9605 eversecure@matco.com

OSCILLOSCOPES

7 in 1 Scope !

CircuitGear CGR-101™ is a unique new, low-cost PC-based instrument which provides the features of seven devices in one USB-powered compact box: 2-ch 10-bit 20MS/sec 2MHz oscilloscope, 2-ch spectrum-analyzer, 3MHz 8-bit arbitrary-waveform/standard-function generator with 8 digital I/O lines. What's more – its open-source software runs with Windows, Linux and Mac OS's! **Only $180**
Saelig
1-888-7SAELIG
info@saelig.com
www.saelig.com

TECH FORUM

This is a READER-TO-READER Column.

All questions *AND* answers are submitted by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. Questions are subject to editing and will be published on a space available basis if deemed suitable by the publisher. Answers are submitted by readers and NO GUARANTEES WHATSOEVER are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

All questions and answers should be sent by email to forum@nutsvolts.com All *diagrams should be computer generated and sent with your submission as an attachment.*

QUESTIONS

To be considered, all questions should relate to one or more of the following:

1. Circuit Design
2. Electronic Theory
3. Problem Solving
4. Other Similar Topics

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Include your Name, Address, Phone Number, and email. Only your Name, City, and State will be published with the question, but we may need to contact you.
- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions are subject to editing.

ANSWERS

- Include in the subject line of your email, the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed. Be sure to include your mailing address or we cannot send payment.
- Only your Name, City, and State, will be printed, unless you say otherwise. If you want your email address included, indicate to that effect.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

>>> QUESTIONS

Radio Read Interrogation Device

My city has installed an Invensys water meter with a sensus radio read transceiver. I would like to build/buy an interrogator device so I can transfer daily/hourly water use to my computer in order to monitor water consumption. Is this possible without buying an industrial reader?

#10091 Burkhard Lehmann
Brentwood, CA

Flashing LEDs

I need a parts list and schematic on how to create flashing lights on small scale emergency vehicles to be used on a slot car racing layout.

#10092 Bob Farrell

Flip-Style Enclosure

I want to use the flip style package (like a "flip-style" cell phone) for an electronics project. It's sometimes referred to as a book-style package solution, where there are electronic functions integrated on both sides of the hinge. I am having trouble identifying the best interconnect products to use for the hinged interface. Can I develop a prototype on a (reasonably) low budget?

#10093 William Quillen
Laurel, MD

High Current Heater

I'm trying to raise the temperature of a tungsten heater from room temperature (25 C to 900 C) with a ramp of one hour. My filament is very small and hence has a small resistance — 0.08 ohm at 1,200 C. At room temperature, its resistence is 12-13 times smaller. Powering the filament is a huge 50 amp variable transformer. I am also using a temperature controller (Omega cni32). Most power supplies I have seen use a phase angle firing SCR with soft start and current limiting capabilities.

#10094 Hugo Leon
Champaign, IL

Remote Temperature Logger

I want to monitor the temperature of my attic during the summer months.

Ideally, I'd also like to know how long the roof fan runs for, but it's hard wired and probably more difficult. I considered doing this by using a sensor to detect the sunlight. As the fan blades spin, the device would count the turning of the fan blades.

I'll settle for a simple temperature detector that can send the data to my PC and some program that will graph the temperature over time.

The attic isn't used so a long averaging time constant isn't required because nobody is walking by disturbing the surrounding air.

I considered a simple thermistor with a 5-10 second RC circuit going into a Linx device that will transmit the data back to the PC. I would also need

some program that would receive, interpret, and graph the data.

#10095 **Peter**
Boston, MA

Outdoor DTV Antenna Tuning Control

I have a RadioShack antenna rotor that I would like to have automatically controlled to the signal strength of the DTV station I have selected. Is there a circuit I can attach to the antenna control knob that will adjust it to the DTV station that I am viewing?

#10096 **John Szymanski**
Mt. Airy, MD

Lead Acid Batteries

Does anyone know of a supplier of re-buildable batteries or even parts suppliers for them? I need a small battery for experimental use. I must be able to change the plates as needed.

#10097 **Harry Pedersen**
Yelm, WA

>>> ANSWERS

[#6091 - June 2009]
DC Motor and Inverters

Can I run a permanent magnet 90 VDC motor on a 1,500W inverter? I need to reverse the motor and was going to run the inverter output through a full wave rectifier.

The best way to hook up your 90V DC motor is through a DC/DC converter. Your inverter has a "front end" which is basically a DC/DC converter up to about 135-145 volts with a chopper on the other end. A "modified" sine wave is the result. The only thing necessary is the DC/DC converter.

An eight amp 90 VDC motor is approx. 1 HP, but requires about 250-600% starting current, depending upon load and motor design. Centrifugal pumps and fans are easy loads while compressors and positive displacement pumps are the worst; 1,500W is only about 200%, but some inverters are specifically designed to handle large surge currents.

Walter Heissenberger
Hancock, NH

[#6092 - June 2009]
Three Volt LED Solar/Charger

Most, if not all, outdoor pedestal lights are 1.5 volts with a very weak LED. With the advent of super bright >10,000 mcd white LEDs, we need a circuit we can drop in (after gutting the old one) that will give a meaningful light source. I entertained a Maxim DC-DC step-up but the existing circuits are current limited. So, how about a 3.x solar source, photocell, a pair of 1.5 VDC batteries, and the charger circuit with photocell switch?

#1 Actually, I believe that a constant current DC-DC converter would be the best way to drive an LED for this purpose. This allows for the LED to remain at a constant brightness, even if the voltage from your battery sags. Also, if you want even brighter lights you can string several LEDs together in series, and still have the same current through them.

Although there are plenty to choose from, I have experience with and would recommend Linear Technology's LT1932. It is small in size, requires few external components, and is fairly flexible and easy to use. Also, you can continue to use a single cell rather than complicating the project by changing the power source. A schematic using this driver is shown in **Figure 1**.

One thing to be careful of no matter how you decide to drive your LED, is not to drain your battery too far. Discharging a NiMH battery completely will likely cause permanent damage. If you find that your light is not glowing the whole night, you might want to consider adding either a timer, a sensitive brownout detector, or larger solar cells to fill the battery faster.

Hal Emmer
Setauket, NY

#2 If you refer to the following website, they have many schematics that are based on solar cell circuits. The site is: **www.hobbyprojects.com/S/Solar_Cell_Circuits.html**

You will find the circuit application that you are looking for at this address.

Ralph J. Kurtz
Old Forge, PA

[#6093 - June 2009]
Autoranging Digital Panel Meter

Does anyone know of a self-contained, autoranging digital panel meter? There are lots of fixed, 200 mV range, self-contained digital panel meters that simply require a power supply and appropriate voltage divider to measure a fixed range of input voltages. I would like to measure from 1 m VDC to 400 VDC with three or four digit accuracy. Or, is there a way to make a self-scaling, autoranging voltage dividing input circuit that would then utilize a standard self-contained panel meter to accomplish the same task? There are many good quality DMMs that are fully autoranging, but they are very difficult to disassemble and implement into a stand-alone system. Most have auto power-off circuits and other features that make them too cumbersome to implement.

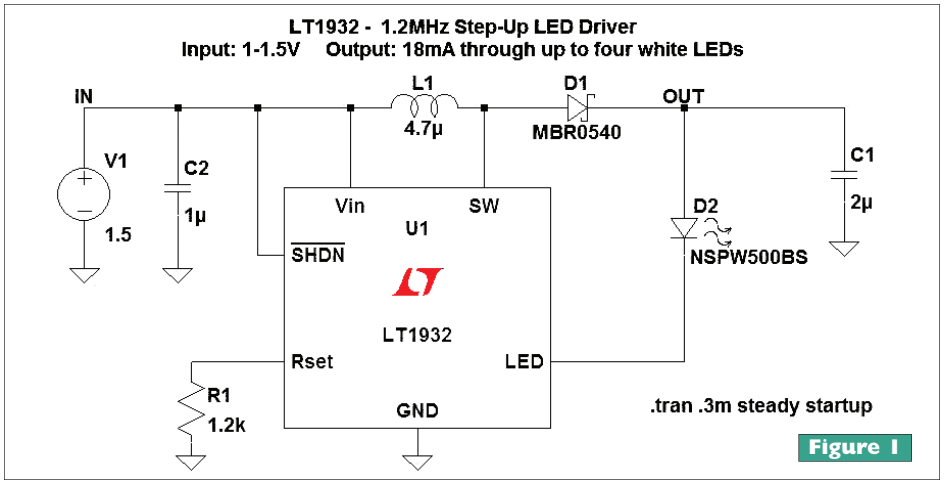


Figure 1

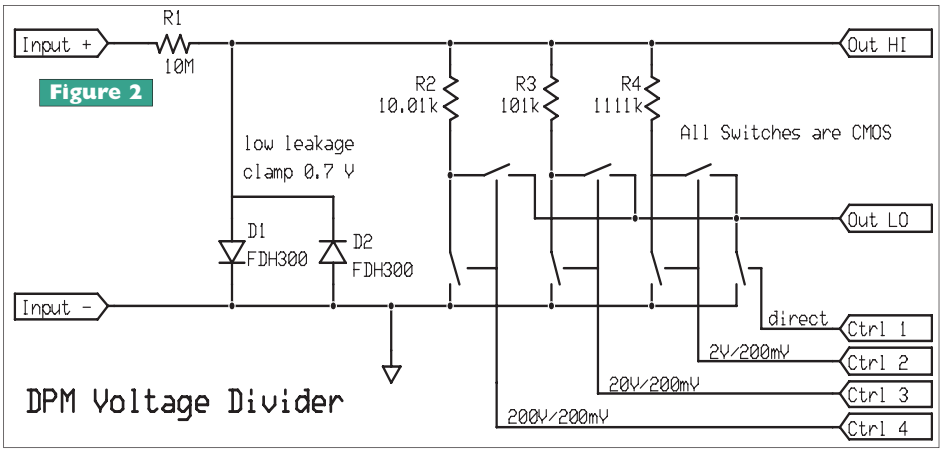


Figure 2

#1 Trumeter makes an autoranging panel meter called the APM (advanced panel meter). You can find more information at **rswww.com/automation**.

As an alternative, you can easily build your own or modify existing ones by adding a voltage divider. The divider is switched by either the panel meter circuitry (see Intersil AN046) or a microcontroller such as the PIC12F675. **Figure 2** shows the principle. The switches can be CD4066s or DG200-series switches available from several manufacturers. Linear Technology and Maxim make high performance switches based upon the 200 series, which are superior. The software is fairly simple: If the count is too low, switch to a lower range. If it is too high, switch to a higher range. The outputs of the PIC also control the decimal point. The PIC can do everything, with either an internal 10-bit A/D converter or an external one for higher accuracy.

Walter Heissenberger
Hancock, NH

#2 Intersil application note AN046 describes an autoranging digital panel meter based on the ICL7106 LCD DVM chip. "This application note describes a technique for auto-ranging a battery operated DVM suitable for panel meter applications." **[1]** This application note also provides hints on adapting the ICL7107 LED version to autoranging.

If you can find a panel meter based on one of these chips, it should be adaptable by adding the circuitry described in AN046 to a small circuit board. Though, considerable additional circuitry is required.

Open a prospective panel meter to see if the analog-to-digital converter chip is identifiable. If you find a blob of epoxy hiding a bare die, identification will not be possible. The formerly available ICL7106EV/KIT evaluation kits with a circuit board do not seem to be available anymore. The alternative of laying out a circuit board is a major project if only a couple of meters are needed. Consult the ICL7606 datasheet for critical analog components if building from scratch. **[2]**

The obsolete NJU9212 digital multimeter chip with auto-ranging built in might also be of interest. **[3]**

References:

[1] Building a Battery Operated Auto Ranging DVM with the ICL7106, **www.intersil.com/data/an/an046.pdf**

[2] ICL7106, ICL7107 Datasheet, **www.intersil.com/data/fn/fn3082.pdf**

[3] NJU9212 Datasheet, **www.datasheetdir.com/go/-xxb-cj-jnckv.pdf**

Dennis Crunkilton
Abilene, TX

[#6094 - June 2009]
Monitor Home UPS

I would like to be able to use an oscilloscope PC application to monitor the 120/240 output of my UPS. I found a couple of applications that utilize the PC's sound input.

Can the 240V output be effectively and safely reduced to the voltage level of the PC mike input?

I'm assuming you want to feed an AC signal to your PC's sound card. Since you're using the Microphone input (per your letter), you need a very small signal as the input is designed for a low level dynamic microphone.

Figure 3 should do the trick. The transformer (L1) provides electrical isolation between the 220 VAC UPS output and the rest of the system. B1 (pilot lamp) provides a load for the transformer, gives an indication the UPS output is active, and helps keep "extraneous noise" from appearing on the transformer's output. The resistor divider (R1, R2) is designed to send a six millivolt AC signal to the microphone's input. Adjust R2's value if you need a larger or smaller signal to the PC's microphone input. Use WELL-SHIELDED audio cable between R2's output and the 3.5 mm phone plug to minimize stray noise, pickup, etc. and do your best to keep that cable away from other transformers and AC cords.

Wiring isn't too critical point-to-point will work and keep the SHIELD connections of the audio cable ends as short as possible. Because you're dealing with LETHAL VOLTAGE at the transformer's primary input, make sure you HEAVILY INSULATE the transformer's PRIMARY SIDE connections. Install everything in a metal hobby box for extra shielding. IMPORTANT: The listed Jameco transformer is designed for 120 VAC or 220 VAC primary operation. For 220 VAC input, make sure you connect both primary wirings in series (pins 2 and 4) or the transformer may be damaged!

Ken Simmons
Auburn, WA

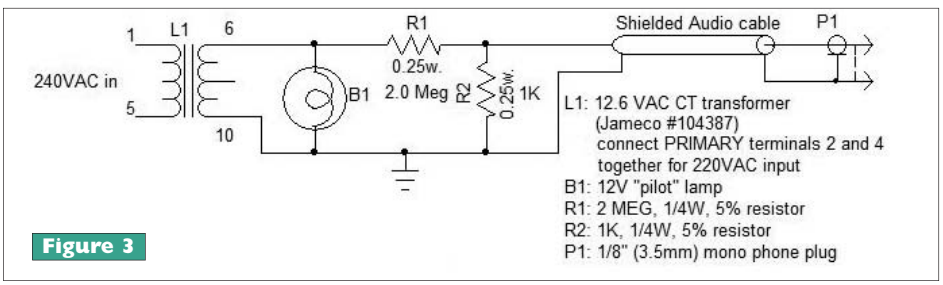


Figure 3

■ LOOK FOR ■ SEARCH FOR ■ FIND

Find your favorite advertisers here!

AD INDEX

AMATEUR RADIO AND TV

Ramsey Electronics, Inc. 24-25

BATTERIES/ CHARGERS

Cunard Associates 33

BUYING ELECTRONIC SURPLUS

Earth Computer Technologies 33
Jaycar Electronics 59

CCD CAMERAS/ VIDEO

Circuit Specialists, Inc. 82-83
Ramsey Electronics, Inc. 24-25

CIRCUIT BOARDS

AP Circuits 58
Cunard Associates 33
Dimension Engineering 30
ExpressPCB 17
PCB Core 8
PCB Pool 11

COMPONENTS

Front Panel Express LLC 23
Fun Gizmos 33
Jameco 4
Lemos International Co., Inc. 11
Linx Technologies 65
Mouser Electronics 9
SparkFun Electronics 3

COMPUTER

Hardware

ActiveWire, Inc. 33
Earth Computer Technologies 33

Microcontrollers / I/O Boards

Abacom Technologies 8
Demand Peripherals 33
Fun Gizmos 33
HobbyLab 33
microEngineering Labs 71
Mouser Electronics 9
Net Media 2
Parallax, Inc. .....Back Cover
Pololu Robotics & Electronics 58
Solarbotics/HVW 14
Technological Arts 33
Trace Systems, Inc. 30
XGameStation 33

DESIGN/ ENGINEERING/ REPAIR SERVICES

Dynamic Design Mexico 32
ExpressPCB 17
Front Panel Express LLC 23
PCB Pool 11
Trace Systems, Inc. 30

EDUCATION

Command Productions 31
Demand Peripherals 33
PAiA 58
Technological Arts 33
XGameStation 33

EMBEDDED TOOLS

Mouser Electronics 9
NetBurner 7

ENCLOSURES

Integrated Ideas & Tech. 23
Front Panel Express LLC 23

KITS & PLANS

DesignNotes.com, Inc. 33
Earth Computer Technologies 33
Images Scientific Instruments 33
Jaycar Electronics 59
NetBurner 7
PAiA 58
QKITS 33
Ramsey Electronics, Inc. 24-25
Solarbotics/HVW 14
XGameStation 33

MISC./SURPLUS

All Electronics Corp. 39
Front Panel Express LLC 23
Surplus Gizmos 51

MOTORS

Jameco 4

PLASTIC PARTS

Dynamic Design Mexico 32

PROGRAMMERS

Dynamic Design Mexico 32
Images Scientific Instruments 33
microEngineering Labs 71

RF TRANSMITTERS/ RECEIVERS

Abacom Technologies 8
Linx Technologies 65

ROBOTICS

Demand Peripherals 33
Fun Gizmos 33
HobbyLab 33
Images Scientific Instruments 33
Jameco 4
Lemos International Co., Inc. 11
Lynxmotion, Inc. 11
Net Media 2
Pololu Robotics & Electronics 58
Robot Power 23
RoboteQ 32
Solarbotics/HVW 14
SparkFun Electronics 3

SATELLITE

Lemos International Co., Inc. 11

SECURITY

Linx Technologies 65

TEST EQUIPMENT

Circuit Specialists, Inc. 82-83
DesignNotes.com, Inc. 33
Dimension Engineering 30
Electronic Design Specialists 65
HobbyLab 33
Jaycar Electronics 59
LeCroy 5
Trace Systems, Inc. 30

TOOLS

NetBurner 7

VIDEO DISPLAY

Decade Engineering 33

WIRE, CABLE AND CONNECTORS

DesignNotes.com, Inc. 33
Jameco 4
SparkFun Electronics 3

Abacom Technologies 8
ActiveWire, Inc. 33
All Electronics Corp. 39
AP Circuits 58
Circuit Specialists, Inc. 82-83
Command Productions 31
Cunard Associates 33
Decade Engineering 33
Demand Peripherals 33
DesignNotes.com, Inc. 33
Dimension Engineering 30
Dynamic Design Mexico 32
Earth Computer Technologies 33
Electronic Design Specialists 65
ExpressPCB 17
Front Panel Express LLC 23
Fun Gizmos 33
HobbyLab 33
Images Scientific Instruments 33
Integrated Ideas & Tech. 23
Jameco 4
Jaycar Electronics 59
LeCroy 5
Lemos International Co., Inc. 11
Linx Technologies 65
Lynxmotion, Inc. 11
microEngineering Labs 71
Mouser Electronics 9
NetBurner 7
Net Media 2
PAiA 58
Parallax, Inc. .....Back Cover
PCB Core 8
PCB Pool 11
Pololu Robotics & Electronics 58
QKITS 33
Ramsey Electronics, Inc. 24-25
Robot Power 23
RoboteQ 32
Solarbotics/HVW 14
SparkFun Electronics 3
Surplus Gizmos 51
Technological Arts 33
Trace Systems, Inc. 30
XGameStation 33

Economy 1U & 2U 19" Rack Mount Chassis with Aluminum front panels

Thease chassis are shipped assembled The Black Anodized Aluminum Front Panel comes pre-drilled for easy rack mounting on to a standard 19" Rack. The steel chassis is painted black.

Item#	37-1U	37-2U
Front Panel Dimenisons	485 mm x 44 mm 19.09in x 3.46in	485mm x 88mm 16.92in x / 19.09in x 11.81
Outside Dimensions	430mm x 300mm x 44mm 16.92in x 11.81in x 1.73	443mm x 300mm x 83mm 17.44in x 11.81in x 3.26in
Inside Dimensions	425mm x 295mm x 35mm 16.73in x 11.61in x 1.37in	435mm x 295mm x 80mm 17.12in x 11.61in x 3.14in
Price	$34.95 ea.	$39.95 ea.

ESD Safe, CPU Controlled, SMD Hot Air Rework Station

What every shop or lab needs to deal with todays SMD designed circuit boards. OEM manufactured just for Circuit Specialists Inc., so we can offer the best price possible! A multi-technology assembly and repair station. A wide selection of nozzles are also available.

- CPU Controlled
- Built-in vacuum parts handling wand
- Air Pump: Diaphragm special-purpose lathe pump
- Capability: 23L/min (Max)
- Temperature Range: 100°C~480°C/212°F~896°F
- 15-Minute Stand-By temperature "sleep" mode
- Power:110/120 VAC, 320 W maximum

Item # **CSI825A++**

$99.00

One Dollar Upgrade !!

Wow! Now thats a lot for only a Dollar more!!

You get the CSI2205D DMM prefitted into our 45-1 Protective Case for only one dollar more than the price of the CSI2205D alone.

The CSI2205D Micro Control Unit auto-ranging DMM is designed for measuring resistance, capacitance, DC & True RMS AC voltage, DC & True RMS AC current, frequency, duty cycle and temperature, along with the ability to test diodes, transistors and continuity.

Regular Price $59.00

The 45-1 case is ideal for transporting small electronics & other delicate items.

Regular Price $29.00

$88.00 if purchased Seperatly!
Save $28.00!!!

Item# **CSI2205D-BUNDLE**

$60.00

3 in 1 FOCUSED Infrared Soldering/Repair System

The CSI720 Three in One Focused Infrared Welding System generates heat through a concentrated infrared heat wave, providing precise soldering without movement of surrounding components.

ESD Safe, Focused Infrared Welding Station
For reworking BGAs, micro BGAs, QFPs, PLCCs, SOICs, small SMD and other circuit board components. Unit produces a concentrated infrared heat wave, for precision soldering. Infrared soldering eliminates movement of surrounding components, and marks on reworked PCB's, both associated with standard hot air gun reworking.

3 in 1 Repairing System
Combines the function of an Infrared Welding Tool, Soldering Iron and Pre-heater.

Full Digital Control with LED Displays
Allows precision setting of welding temperature & time, soldering iron and pre-heating temperatures.

Closed loop temperature control
For instant and precise process adjustments.

Adjustable Infrared Tool Post
Stable and adjustable Infrared welding tool holder for increased precision soldering and hands free operation.

Adjustable Eye shield & Welding Goggles
To protect users from harmful light rays.

Uses infrared heat wave technology instead of the conventional hot air, effectively solves the major problem being encountered when using the hot air gun, which is the movement of surrounding components while reworking.

Item # **CSI720** **$1,399.99**

60MHz Hand Held Scopemeter with Oscilloscope & DMM Functions

Who Says
you can't take it with you?
With the DSO1060 YOU CAN!

You get both a 60 MHz Oscilloscope and a multi function digital multimeter, all in one convenient lightweight rechargeable battery powered package. This power packed package comes complete with scopemeter, test leeds, two scope probes, charger, PC software, USB cable and a convenient nylon carrying case.

- 60MHz Handheld Digital Scopemeter with integrated Digital Multimeter Support
- 60MHz Bandwidth with 2 Channels
- 150MSa/s Real-Time Sampling Rate
- 50Gsa/s Equivalent-Time Sampling Rate
- 6,000-Count DMM resolution with AC/DC at 600V/800V, 10A
- Large 5.7 inch TFT Color LCD Display
- USB Host/Device 2.0 full-speed interface connectivity
- Multi Language Support
- Battery Power Operation (Installed)

NEW ITEM

Item # **DSO1060** **$549.00**

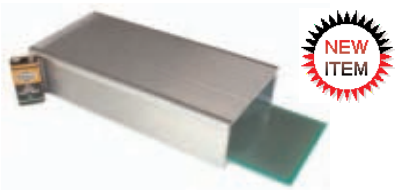
ESD Safe SMD & Thru-Hole Rework Station

An SMD rework station & soldering station in one handy unit! Perfect for shops & labs dealing with todays SMD board designs. Comes with an ESD safe soldering iron and a Hot Air Wand with 3 Hot Air Nozzles. A wide range of nozzles are also available.

Item # **CSI906** **$99.00**

Extruded Aluminum Enclosures with Fitted Perfboards inclued

These attractive cases are made of extruded polished aluminum with internal slots that can accommodate 2 PCBs up to 0.08" thick. Mounting tabs at each end aid in securing the box to a surface. One PCB is included with each enclosure (2nd PCB optional).



Item # 17-10A	Item # 17-10B	Item # 17-10C
Outside Dimensions 70 x 32.5 x 152.4 mm 2.75 x 1.27 x 6 in	**Outside Dimensions** 80 x 37.5 x 179 mm 3.14 x 1.47 x 7.04 in	**Outside Dimensions** 100 x 47.5 x 203 mm 3.93 x 1.87 x 7.99 in
Inside Dimensions 55 x 25 x 152.4 mm 2.16 x 0.98 x 6 in	**Inside Dimensions** 65 x 30 x 179 mm 2.55 x 1.18 x 7.04 in	**Inside Dimensions** 85 x 40 x 203 mm 3.34 x 1.57 x 7.98 in
PCB Size 50 x 20 x 152 mm 1.95 x 0.78 x 5.98 in	**PCB Size** 60 x 25 x 179 mm 2.36 x 0.98 x 7.04in	**PCB Size** 80 x 35 x 203 mm 3.14 x 1.37 x 3.98 in
Perfboard Specifications 20 x 57 plated thru holes on 0.1in centers on double-sided FR-4 board	**Perfboard Specifications** 24 x 67 plated thru holes on 0.1in centers on double-sided FR-4 board	**Perfboard Specifications** 32 x 77 plated thru holes on 0.1in centers on double-sided FR-4 board
1+ $9.95 10+ $8.49	1+ $12.95 10+ $10.50	1+ $14.95 10+ $13.95

34 Channel USB Logic Analyzer

The CSI5034 is a sophisticated, portable, and easy-to-use 500MHz, 34-channel logic analyzer equipped with features found only in more expensive bench type instruments.

Using advanced large-scale integrated circuits, integrated USB 2.0, CPLD, FPGA, high-frequency digital circuitry, embedded systems, and other advanced technology, make the CSI5034 your best choice in pc-based logic analyzers The CSI5034 is suitable for electronic measurement engineers, college students in scientific research and development and teaching assistants.

- 34 input channels capable of simultaneously monitoring data and control information, and is capable of capturing narrow pulses and glitches that may be missed by other test equipment.
- Delay feature provides the ability to capture data around the waveform, both before and after the desired trigger signal. This allows the operator to view the data at multiple points in the data stream
- Memory feature stores multiple data points for error analysis of the unit under test and to aid in locating defective components.
- Intuitive and flexible viewing screens to facilitate analysis of the system under test. Data can de displayed as binary, decimal, or hexadecimal values.
- Can be triggered in a variety of ways (rising edge, falling, edge or both) , and also has an advanced trigger function that allows logic operations to be performed on the data before a trigger is generated. This provides the ability to trigger on a specific data byte or word from any of the monitored channels.

NEW ITEM

Item # **CSI5034** **$329.00**

Triple Output DC Bench Power Supplies

- Output: 0-30VDC x 2 @ 3 or 5 Amps & 1fixed output @ 5VDC@3A
- Stepped Current: 30mA +/- 1mA

Item #:	Price 1-4	Price 5+
CSI3003X3 0-30Vx2@3A	$198.00	$193.00
CSI3005XIII 0-30Vx2@5A	$259.00	$244.00

Premium All-In-One Repairing Solder System

The BlackJack SolderWerks BK6000 Repairing System is a digital multipurpose reworking system that incorporates a Hot-Air Gun, Soldering Iron, (compatible with leaded solder or lead free solder), with integrated smoke absorber and a desoldering Gun.

Item# **BK6000** **$199.00**

Hot Air System w Soldering Iron & Mechanical Arm

The BK5000 from BlackJack SolderWerks provides a very convenient combination of hot air & soldering in one compact package. The hot air gun is equipped with a hot air protection system providing system cool down & overheat protection.

Item# **BK5000** **$119.00**

Hot Air with Vacuum I.C. handler & Mechanical Arm

The BlackJack SolderWerks BK4050 is designed to easily repair surface mount devices. Its digital display & tactile buttons allows easy operation & adjustments. The BK4050 includes a hot air gun and a vacuum style I.C. handler.

Item# **BK4050** **$119.00**

Thermostatically controlled desoldering station

The BlackJack SolderWerks BK4000 is a thermostatically controlled desoldering station that provides low cost and solid performance to fit the needs of the hobbyist and light duty user. Comes with a lightweight desoldering gun.

Item# **BK4000** **$119.00**

Digital Display Solder Station for Lead Free Solder

The BK3000LF is a compact unit designed to be used with lead free solder that provides reliable performance featuring microprocessor control and digital LED temperature display. A wide range of replacement tips are available.

Item# **BK3000LF** **$74.95**

Compact Digital Display Solder Station

The BK2000+ is a compact unit that provides reliable soldering performance featuring microprocessor control and digital LED temperature display. A wide range of replacement tips are available.

Item# **BK2000+** **$56.95**

Compact Soldering Station

The BlackJack SolderWerks BK2000 is a compact unit that provides reliable soldering performance with a very low price. Similar units from other manufacturers can cost twice as much. A wide range of replacement tips are available.

Item# **BK2000** **$36.95**

Featuring spot-on, dual-laser aiming, the TN01U close-focus, non-contact IR thermometer measures the temperature of electronic components as small as 0.1-in. with pin-point accuracy. Compact and lightweight, the instrument provides a large LCD and a bright dual-laser aiming system that allows for accurate aiming. Features include a measurement spot size of 2.5-mm in diameter at distances up to 18 mm, measurement range from -55ºC to +220ºC,(-67-428 deg F) an accuracy of ±2% of reading or ±2ºC whichever is greater, a repeatability of ± 0.2ºC, display resolution of 0.1ºC, and a response time of 1s. Operating with two AAA batteries providing 18 hours of continuous use, the instrument measures. This is the most advanced infrared thermometer manufactured today providing fast, accurate, non-contact component temperature measurements for hardware designers, Test, QA and Service professionals.

Item # **TN01U**

$129.00

CircuitSpecialists.com
1000's of Items Online!
1-800-528-1417
Fax: 480-464-5824
Since 1971

Dual Output DC Bench Power Supplies

High stability digital read-out bench power supplies featuring constant voltage & current outputs. Short-circuit & current limiting protection is provided. SMT PC boards and a built-in cooling fan help ensure reliable performance & long life. All 3 Models have a **1A/5VDC Fixed Output** on the rear panel.

Item #:	Price 1-4	Price 5+
CSI3003X-5 0-30V/0-3A	$119.00	$112.00
CSI5003X5 0-50V/0-3A	$127.00	$119.00
CSI3005X5 0-30V/0-5A	$129.00	$122.00

Temprature Controlled Reflow Oven

The HHL3000 Reflow Oven is a highly versatile tool used for reflowing and preheating different surface Mount technology (SMT) components and printed circuit boards (PCB's). The system utilizes a microcontroller to effectively amd efficently manage the working temperature while facilitating the duration of the heating process. A bright LED display clearly displays the time and temperature along with a fully digital control panel for ease of use and monitoring.

The HHL3000 makes use of infrared (IR) heat wave technology to distribute heat evenly on the component and PCB. Included is an integrated temperature sensor that allows positioning in such a way that the measurement of the actual temperature of PCB and components can be obtained. This minimizes damage to the PCB and its components due to thermal shock or low level temperature conditions.

FUNCTIONS and FEATURES

* Microprocessor-controlled equipment.
* Direct PCB temperature measurement, improves accuracy and lessens damage or distortion.
* Five (5) temperature and time control points with automatic slope adjustment. Configurable to suit different solder paste and circuit boards.
* Two (2) default profiles suitable with most common solder paste specifications.
* Quick and easy resetting of control points for precise tuning of reflow profiles.
* Built-in safety feature of industry standard 0.01°C/s to 3°C/s rising slope.
* Fully digital panel controls and read-out of time and temperature for monitoring and ease of use.
* Highly compatible with lead-free applications.

Item# **HHL3000** **$949.00**

380 watt Pure Sine Wave Inverter

* Pure Sine Wave Output
* USB 5V/500mA Supply Plug
* High temp alarm
* Output overload alarm
* Output short circuit alarm
* Low / High battery alarm
* High surge capacity for starting demanding loads

Continuous Output:	380W
Surge Output:	650W
Voltage (AC)	100V~120V
Frequency:	60Hz
Waveform:	Pure Sine Wave
Regulation (Typ.):	Vrms +/-3%
Total Harmonic Distortion:	THD <3%
USB Output(Typ.)	DC 5V +/-5% 500mA
Input Voltage:	12V
Low Battery Alarm:	10.5V
Low Battery Protection:	10V
High Battery Protection:	16V
No Load Current:	500mA
Efficiency:	>83%
Size:	240 x 119 x 60 mm

Item# **SI-12038E** **$129.00**

Rugged 6000 Count AutoRanging DMM

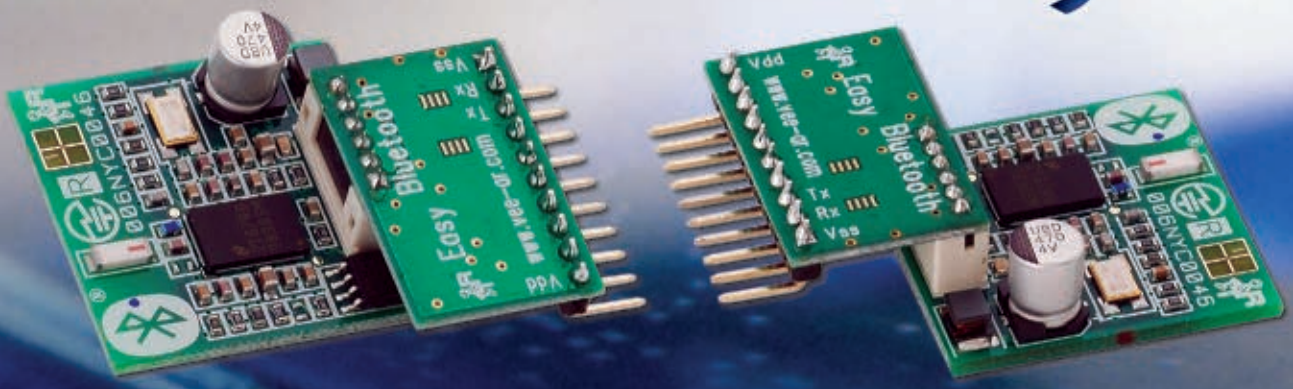
This is a very solid and versatile DMM manufactured by Precision Mastech. The MS8240C auto ranging DMM features a full scale count of 6000 and a 3 5/6 digit LCD display with 61 segment bar graph. This meter is designed to meet IEC1010-1 CAT III over voiltage protection and implements a double insulation design.

Item# **MS8240C**

$39.00

Key features include:
*Push Button Min/Max reading
*Data Hold
*Relative Value (measure against a user selected reference value)
*LPF key (Low Pass Filter) to reduce the influence of high harmonics in the AC voltage & current modes)
*Back Lit display
*Hz/Duty function
*Includes deluxe set of test probes rated to 1 KV Cat III/10 Amps
*Includes Temp probe
*Includes nylon carry/storage case

BLUETOOTH MADE EASY!



The **Easy Bluetooth Serial Module** (#30085; $69.99) is an effective and low-cost solution to free your hardware applications from wires. The module is small in size, and with its SIP header design, it can fit on any 0.1" spacing breadboards for rapid prototyping. The module is compliant with Bluetooth 1.x and 2.0 allowing it to communicate with a broad range of Bluetoth devices. The Easy Bluetooth Module is compatible with all the Parallax microcontrollers.

The module has two parts, the RBT-001 module and the SIP with voltage regulator PCB. With the on-board regulator, the module can be connected to voltages higher than 3.3 VDC (such as the Parallax Board of Education 5 VDC regulated supply) without worry of damaging the unit, while the RX and TX can utilize serial communication at CMOS and TTL levels.

Application Ideas:

- Control a Boe-Bot® robot via Bluetooth from a PC, mobile phone, or another Bluetooth module
- Communicate with a device or project wirelessly

Features:

- 1.x & 2.0 Bluetooth compliant
- Easy serial communication
- Class 2 operation (nominal range up to 30 m)
- Low power consumption
- On-board regulator for safe operations across various voltages

Key Specifications:

- Power requirements: 3.3 to 5 VDC
- Communication: UART Command/Data Port supports up to 921.6k baud rate
- Dimensions: 1.40 x 1.79 x 0.49 in (34.41 x 45.65 x 12.51 mm)
- Operating temperature range: 32 to 113 °F (0 to 45 °C)

Order the **Easy Bluetooth Module** (#30085; $69.99) online at www.parallax.com or call our Sales Department toll-free at 888-512-1024 (Monday - Friday, 7 a.m. - 5 p.m., PDT).

PARALLAX INC.

www.parallax.com

Boe-Bot is a registered trademark of Parallax Inc. Parallax, and the Parallax logo are trademarks of Parallax Inc. Prices are subject to change without notice.